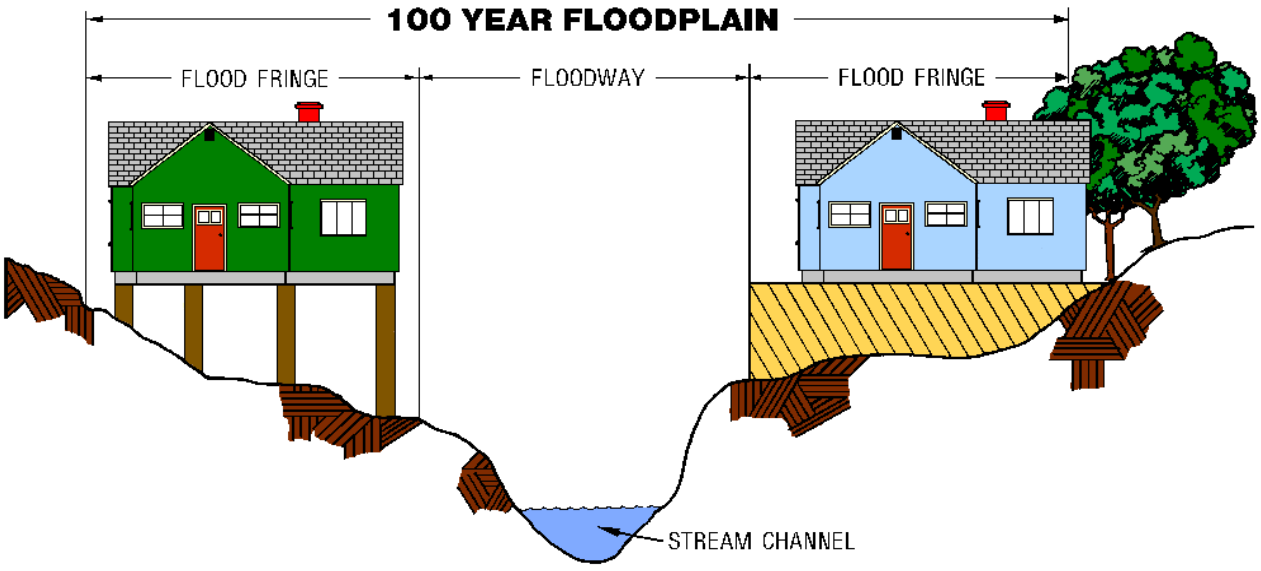
Non-Structural Flood Damage Reduction Within the Corps of Engineers

What Districts Are Doing



US Army Corps of Engineers
Flood Proofing
NATIONAL FLOOD PROOFING COMMITTEE

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PREFACE

Flood damage reduction consists of two basic techniques - structural and non-structural. Structural has historically been the technique most desired by the general public since it modifies the flood and "takes floods away from people" by measures such as channels, levees, and dams. Non-structural flood damage reduction techniques basically "take people away from floods" leaving the flood to pass unmodified.

Non-structural flood damage reduction techniques consist of measures such as relocation, acquisition, flood proofing, flood insurance, flood preparedness/warning/response and public education. These measures have historically not been generally desired by the public and therefore, have not been utilized to their potential extent. This attitude of the general public has been gradually changing with continued implementation of the National Flood Insurance Program and the increasing national interest in a more pristine environment in which to live. This change became more abrupt with the "Great Flood of 1993" that occurred in the Mississippi River Basin. More and more communities no longer want structural flood damage reduction techniques that "disturb" the environment. Instead they want non-structural techniques used to reduce flood damages that do not "disturb" or that can lead to "restoration" of the environment. Non-structural flood damage reduction techniques have proven to be extremely viable in alternatives consisting of total non-structural or a combination non-structural and structural.

The Corps of Engineers National Flood Proofing Committee (NFPC) has recognized that sharing successful non-structural information within the Corps of Engineers may be very helpful to Districts that are considering non-structural alternatives. The NFPC has compiled into this document applicable portions of reports developed by various Districts that show how non-structural projects were formulated, justified, and implemented. Some projects documented were formulated and justified in complete accord with Corps criteria. Other projects documented have not been but were developed in specific response to Congress. Examples of both are included to show the wide range of implementation procedures and authorities that have been used by Districts to make successful non-structural projects.

Some projects documented were only in the early stages of development when contact was made with the respective District while other projects were more advanced. The intent of the NFPC in this regard was to document projects to demonstrate current project development and implementation procedures.

This document contains portions of reports from the following locations:

- Paxton Creek; Harrisburg, Pennsylvania; Baltimore District
- Vermilion River; Lafayette Parish, Louisiana; New Orleans District
- Cypress Creek; Harris County, Texas; Galveston District
- Spring Creek; East Ridge, Tennessee; Nashville District
- Pentz Run; Dubois, Pennsylvania; Pittsburg District

- Tug Fork Basin; McDowell County, West Virginia; Huntington District
- Johnson Creek; Arlington, Texas; Fort Worth District
- Missouri River; Pierre/Fort Pierre, South Dakota; Omaha District
- Middle Creek; Lake County, California; Sacramento District

The NFPC did not rewrite the District reports. Instead, portions were extracted directly form the District reports. This is why the writing "style" format, etc. varies from project to project.

The report also contains selected portions of two documents that provide guidance in formulating and justifying projects. These documents are ER 1105-2-100 dated April 2000 (Planning Guidance Notebook) and IWR Report 88-R-2 dated March 1988 (National Economic Development Procedures Manual - Urban Flood Damage). The selected portions of these documents are pertinent to non-structural flood damage reduction analysis and the difference between this analysis and that for a structural project. This guidance was used to develop all projects documented in this report unless other development criteria was specifically provided by Congress.

New project implementation guidance is now available as a result of Section 219 of the Water Resources Development Act of 1999 (WRDA 99). This new guidance is also contained in this report. The guidance is in the form of a memorandum from James F. Johnson, Chief, Planning and Policy Division, Directorate of Civil Works dated 22 January 2001. It provides changes to the guidance of ER 1105-2-100 dated April 2000 and IWR Report 88-R-2 dated March 1988 in regard to the specific non-structural flood damage reduction measure of flood plain evacuation by relocation or acquisition/demolition. This guidance is required to be used on all projects proposed after enactment of WRDA 99.

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Summary of Projects Documented:

Project - Pentz Run
District - Pittsburg
Location - DuBois, Pennsylvania
Authority - Section 581 of the Water Resources Development Act of 1996
Non-Structural Measures -
- Acquisition
- Dry Flood Proofing
- Elevation
- Relocation
- Flood Warning
- Wet Flood Proofing

Project - Tug Fork Basin
District - Huntington
Location - McDowell County, West Virginia
Authority - Section 202 of the Energy and Water Development Appropriations Act of 1981
Non-Structural Measures -
- Elevation
- Dry Flood Proofing
- Acquisition/Buyout
- Flood Warning

Project - Johnson Creek
District - Ft. Worth
Location - Arlington, Texas
Authority - The Johnson Creek Study was undertaken in GI as an interim of the Upper Trinity Basin , Texas Study. The Upper Trinity Basin Study was authorized by resolution of the Committee on Environment and Public Works, U.S. Senate, adopted April 22, 1988. The project was authorized for construction by Section 101 (b) (14) of the Water Resources Development Act of 1999.
Non-Structural Measures -
- Flood Warning
- Elevation
- Dry Flood Proofing
- Acquisition

Project - Missouri River
District - Omaha
Location - Pierre/Fort Pierre, South Dakota
Authority - Section 136 and 106 of Omnibus Consolidated and Emergency Supplemental Appropriation Act of 1999
- Section 258 of Agricultural Risk Protection Act of 2000
Non-Structural Measures -
- Buyout
- Relocation
- Elevation
- Wet Flood Proofing

Project - Middle Creek
District - Sacramento
Location - Lake County, California
Authority - Public Law 84-99
Non-Structural Measures -
- Acquistion

Project - Paxton Creek
District - Baltimore
Location - Harrisburg, Pennsylvania
Authority - Section 205 of Flood Control Act of 1948
Non-Structural Measures -
- Flood Warning System

Project - Vermilion River
District - New Orleans
Location - Lafayette Parish, Louisiana
Authority -Mermentau, Vermilion, and Calcasieu River and Bayou Teche, Louisiana
Non-Structural Measures -
- Dry Flood Proofing
- Elevation
- Floodwalls
- Levee

Project - Cypress Creek
District - Galveston
Location - Harris County, Texas
Authority - Water Resources Development Act of 1988
Non-Structural Measures -
- Elevation
- Acquisition/Buyout

Project - Spring Creek
District - Nashville
Location - East Ridge, Tennessee
Authority - Section 572 of the Water Resources Development Act of 1996
Non-Structural Measures -

- Levees
- Floodwalls
- Elevation
- Flood Warning
- Acquisition/Buyout

PAXTON CREEK FLOOD WARNING
HARRISBURG, PENNSYLVANIA
BALTIMORE DISTRICT

INTRODUCTION

The Baltimore District, under the general continuing authority of Section 205 of the Flood Control Act, approved June 30, 1948, as amended has prepared this report.

By letter of February 1, 1991, the City of Harrisburg made formal application for a study to be made under the above authority in the interest of investigating non-structural alternatives for flood control along Paxton Creek in Harrisburg, Pennsylvania.

PROBLEM DESCRIPTION

The City of Harrisburg is drained by Paxton Creek and its tributaries, and directly by the Susquehanna River. The Susquehanna River basin has a total drainage area of 27,400 square miles. The Paxton Creek watershed is approximately 27.7 square miles in size and is separated into an upper and lower basin by Wildwood Lake. The upper basin is approximately 19.3 square miles and is a developing rural area with several small towns. The lower basin is 8.4 square miles and is highly urbanized consisting of a major portion of the City of Harrisburg. The flood plain is almost completely developed, and consists of mainly commercial and industrial buildings.

The specific study area is comprised of the area along Paxton Creek from its confluence with the Susquehanna River upstream to Wildwood Lake, a distance of approximately 5 miles.

The Paxton Creek drainage basin is bounded on the north by Blue Mountain, part of the Appalachian Mountain range. To the west, the basin is bounded by a low ridge running approximately north-south through the Commonwealth of Pennsylvania Capital grounds. Wildwood Lake is located in the northwest corner of the basin, and lower Paxton Creek flows from the lake through the City along a gradual decline. The basin is characterized by rolling hills with relatively flat banks along the creek. The average annual temperature is 53 degrees Fahrenheit. The average annual precipitation is about 40 inches and is more or less uniformly distributed throughout the year with the highest rainfall occurring from March to August when the average is 3.5 inches per month.

The Harrisburg Metropolitan Statistical Area (MSA) of Dauphin, Cumberland, and Perry Counties has a population of more than 450,000. Locally the MSA is referred to as the Capital Region. With a 1990 population of 52,376, Harrisburg is the largest city in the MSA. Table 1 provides a comparative population data for the three counties and the City of Harrisburg.

TABLE 1
POPULATION

	1980	1990	% Change
Dauphin County	232,317	237,813	+ 2.4
Perry County	35,718	41,172	+ 15.3
Cumberland County	178,541	195,257	+ 9.4
Total Capital Region	446,576	474,242	+ 6.2
City of Harrisburg	53,264	52,376	- 1.5

SOURCE: U. S. Bureau of Census, 1990

The study area along Paxton Creek is subject to flooding from two sources; the Paxton Creek basin and backwater from the Susquehanna River. Paxton Creek flooding, from intense localized rainfall, tends to be very flashy. This flashiness is created by the relatively small drainage area, rapid runoff caused by the highly impervious nature of the area (i.e., heavy urban development), the steepness of the lower subbasin, and the relatively flat slope of the Paxton Creek channel. The contribution of flooding from the upper basin is observed as a second peak in the discharge hydrograph, after flooding from the lower basin is receding. It is caused by flow attenuation as a result of Wildwood Lake. In addition, a portion of the upstream runoff is diverted from Wildwood Lake to the Susquehanna River that reduces the second peak.

Flooding due to runoff from the Paxton Creek watershed usually occurs before the Susquehanna River stage begins to rise. Flooding along Paxton Creek also occurs as a result of backwater from the Susquehanna River. Moderate to high flood stages on the Susquehanna River back up into the low area creating a ponding effect that can last several days. Under this condition, the flood stage associated with the Susquehanna River is the controlling factor. This source of flooding only affects the lower reaches of Paxton Creek downstream from its confluence with Asylum Run. There is also the potential for combined flooding as a result of intense localized rainfall in conjunction with a flood stage on the Susquehanna River.

The City of Harrisburg has an existing flood warning system for both the Susquehanna River (including flooding along Paxton Creek from Susquehanna River backwater), and within the Paxton Creek basin. Flood forecasts and predicted stages for the Susquehanna River have been refined and are relatively accurate. Forecasts for the Susquehanna River are prepared daily by the National Weather Service (NWS) and provide many hours, and possibly as much as a day or two of advanced warning of possible flooding. Given the reliability of these forecasts, they will not be evaluated further. Therefore, only the flood warning system designed specially for the Paxton Creek watershed flooding will be examined in greater detail.

EXISTING PAXTON CREEK FLOOD WARNING SYSTEM

Flood Preparedness. The City of Harrisburg has an emergency management organization and operates an Emergency Operations Center (EOC) comprised of City personnel on 24 hour standby. The EOC is staffed with personnel from various City departments including police, fire, rescue, and public works. The activities of the EOC are generally described in an "Emergency Operations Plan" (effective September 30, 1990). The Emergency Operations Plan identifies and describes the channels of authority and communication in the event of an emergency, as well as the procedures to follow for a number of identified emergencies including flooding.

The City of Harrisburg is well aware of the flooding potential of Paxton Creek. When the conditions are present which suggest that a flood threat exists, the City is prepared on a moments notice to begin actions which will mitigate the adverse impacts associated with flooding through a number of actions, including blocking and rerouting vehicular traffic and the mobilization of sump pumps.

The City of Harrisburg, Department of Public Works, Traffic Engineering Section, maintains the existing rain and stream gauges, installed in 1984. They replace batteries, clean screens, and test the gages ability to properly transmit data to the receiver/decoder and base station computer at the NWS. Funds for this maintenance come from the City's general maintenance fund. The electronic technicians at the NWS voluntarily maintain the receiver/decoder. The base station computer is maintained as part of the Passaic River Flood Forecasting System.

Flood Threat Recognition. The data collection facilities which are part of the existing flood warning system consists of two rain gauges, located on Lingletown Road (upper sub-basin) and on Calder Street (in the parking lot of the Chromalloy plant). They are of the automatic tipping bucket variety, capable of measuring rainfall intensity and amounts (bucket tips every 0.04 inches). The gages are fitted with a compact electronic system, with its own power supply (battery), which transmits the data by radio signal. The gages report automatically whenever there is an increment of 0.04 inches of rainfall. If no rainfall is occurring, the gages will report at preset time intervals.

A Stream gage is located adjacent to the existing rain gage on Calder Street. It is an automatic stream gage, capable of continuous stage measurements. Similar to the rain gages, the stream gage transmits its data via radio signal. The gage reports automatically whenever a 0.017-foot change in stage occurs.

The back-up stream data collection mechanism involves personnel at the Chromalloy plant who continually staff a guard post building with access to a manual stage gage, located in the vicinity of the automatic rain and stream gages. They are instructed to call the NWS and the City EOC and report stages higher than seven feet.

Data transmitted by the gages is received directly by a base station (composed of a receiver, decoder, personnel computer, and appurtenant devices) located within the Mid Atlantic River Forecast Center (MARFC), National Weather Service NWS), in Harrisburg. The collected data is decoded and processed using appropriated computer software.

There is no formal flood forecast method for Paxton Creek. The MARFC uses early indicators such as rising creek levels, observed rainfall amounts and the probability of continued rain to make warning decisions. Utilization of the software provides the capability for the base station to sound an audible and visual alarm whenever precipitation exceeds predetermined levels of the creek reaches stages of 7, 11, and 12 feet. A stage of 7 feet is interpreted as the point where the potential for flooding is demonstrated, and heightened awareness of the situation is a prudent action, particularly if rainfall is continuing or expected to continue. At a stage of 11 feet, water has begun to leave the banks of the Paxton Creek. At a stage of 12 feet (flood stage), inundation of roads, structures, and structure contents can be expected.

Flood Warning Dissemination. The NWS issues flood watches through their Weather Forecast Office in Philadelphia based on guidance prepared by the MARFC. Flood warnings are issued by the Weather Service Office in Harrisburg usually after consulting the MARFC. The current procedure is to issue flood watches whenever it is determined that the creek stage exceeds 7 feet at the Chromalloy gage. A warning is issued when creek stage exceeds 10 feet and rain is expected to continue. Flood stage occurs at 12 feet.

The NWS disseminates flood watches and warnings for the Paxton Creek via NOAA Weather Radio. Flood watches and warnings are also distributed over NOAA Weather Wire, which is picked up by the Pennsylvania Emergency Management Agency and relayed to the Dauphin County Emergency Management Agency. In addition, MARFC contacts the City of Harrisburg EOC whenever a potential flood threat exists. It should be noted that the calls are places on an informal basis, MARFC has no formal agreement to contact the City.

The City may contact flood prone property owners if information received from the MARFC and/or local observations suggests a potential flood threat. The City uses personnel from the EOC to manually telephone the affected flood plain occupants. Using all four available telephone lines, this process can take 35 minutes or more to complete.

Flood Response. The City of Harrisburg has an existing Emergency Operations Plan, which outlines the general concepts of operation, organization, responsibilities, administration, and logistics of the Emergency Operation Center and the procedures to follow for specific emergency situations. Among the specific emergency situations for which they have prepared is flooding from all sources, including Paxton Creek. After the release of a flood warning for Paxton Creek, public safety officials begin to barricade roads and reroute traffic away from the flooded areas. The City is prepared for more extensive responses including evacuations, rescue, and major clean up under those situations calling for such actions. It is the responsibility of the individual property owner to prepare for potential flooding, and respond to a flood warning in an appropriate manner. A response action by flood plain occupants can include elevating or relocating damageable building contents and inventory, or motor vehicles, as well as evacuation from the flood plain.

DEFICIENCIES IN EXISTING FLOOD WARNING SYSTEM

Several deficiencies in the existing system have been identified. Each is described below.

Lack of Local Participation in the Flood Warning. The City of Harrisburg has no direct access to real time precipitation or stage data. The existing flood warning system is essentially operated by the MARFC, who do so on a voluntary basis. However, with its present resources it is difficult for MARFC to provide timely forecasts (watches/warnings) for the entire region for which they are responsible. Given Paxton Creek crests relatively quickly after (or during) rainfall, there may not be sufficient time to collect, analyze, prepare a forecast, and disseminate the warning which provides for adequate time for a response. In the event of large regional storms, the need for forecasts exceeds the present capabilities of the MARFC. In other words, the MARFC has required duties to perform which restrict their voluntary contribution to the Paxton Creek system.

For example, during the early morning hours on August 7, 1991, a storm event produced three inches of rain in a relatively short time span resulting in flooding of a portion of the flood plain. The MARFC, who was monitoring the event, was unable to provide a warning to the City before water left the banks of the creek. This illustrates the need for the City of Harrisburg to become actively involved in flood threat recognition, (i.e., data collection and interpretation) in order to reduce the time required for flood threat recognition and warning dissemination thereby providing a greater flood warning time.

Lack of a Base Station (Under Future Without Project Conditions). The lack of local participation in the flood warning system is exacerbated by the identified future project condition. This condition will see the MARFC relocating its present operation, including base station computer, to State College, Pennsylvania, and located 70 miles northwest of Harrisburg. After the relocation, they will no longer be able to provide their voluntary services towards operating the existing system. A large portion of their capability to voluntarily operate the system will no longer be available for the Paxton Creek system.

Without the base station computer to process data from the gages, the system reverts from an automated mode to a manual mode. I. E., data collection will rely on visual observation of the manual stream gage at the Chromalloy location and observed rainfall. Reliability and timeliness of data are compromised, thereby increasing the time for flood threat recognition.

Lack of a Back-up Base Station. The first two noted deficiencies point to the critical nature of a base station (computer). The ability to receive and interpret real time data on rainfall amounts and creek stages are critical components of flood threat recognition made possible by the base station equipment. Should a lone base station fail, the system would have to rely on telephone communications with the Chromalloy plant guard post for creek stages, or on radar information or other rainfall gages outside the watershed for precipitation data. This procedure would significantly delay flood threat recognition and delay the dissemination of flood warnings.

Lack of an Additional Rain Gage. Of the two existing rain gages in operation as part of the existing system, only one is located in the lower sub-basin (Chromalloy plant). Should this rainfall gage cease to operate due to malfunction or damage, the only back up is the rain gage at Lingletown Road. The Lingletown gage, which is in the upper sub-basin, may not indicate the rainfall occurrence in the more critical lower watershed. An additional rain gage in the lower sub-basin will not only increase system reliability, but also provide additional information on the area distribution of rainfall.

Lack of Timely Warning Dissemination. The timely dissemination of a flood warning under the existing system is severely limited. Given the relative short time frames encountered between the time a flood threat is recognized and the onset of inundation, the speed and dependability of a flood warning is crucial if life saving and damage avoidance activities are to be enacted. Relying on the NWS to broadcast a flood warning over weather radio would assume that affected flood plain occupants are tuned into the appropriate station during potential flood threats. The likelihood that this occurs, particularly during the early morning hours is suspect. Furthermore, even if the City makes a timely decision to issue a warning, the limited capability of manual telephone dialing and four simultaneous contacts will not provide sufficient warning time to a majority of the flood plain occupants given the flashiness of flood along Paxton Creek. Hence flood warning time would be increased with quicker warning dissemination.

Lack of Stage Forecast Model. At this time flood watches and warnings are essentially based on observed creek stage and the likelihood of continued precipitation. A better understanding of the flooding response to rainfall may increase the accuracy of a flood forecast (i.e., flood threat recognition) and provide additional time for flood response activities.

PROBLEM IDENTIFICATION

As a result of the examination into the existing flood warning system, three specific problems have been identified. The existing system does not have the capability for a timely or accurate flood threat recognition, or the capability to disseminate flood warnings in a timely manner. Consequently, the amount of flood warning time available to respond to a flood warning is severely limited. Furthermore, the potential exists for complete system failure due to the lack of back-up capabilities for critical system components.

PLAN FORMULATION

Planning Objectives and Constraints. Given the previous descriptions and discussions of the existing flood warning system, as well as an examination of the structural and non-structural solutions investigated and/or implemented, an improvement to the existing flood warning system is the only option remaining to the City of Harrisburg for the reduction of potential flood damages along Paxton Creek. As such, plan formulation will focus on this alternative. For the Paxton Creek Local Flood Warning Study the following planning objectives and constraints were identified for Paxton Creek from the confluence of the Susquehanna River upstream to Wildwood Lake for a 20 year period of analysis:

1). Reduce economic losses from flooding.

2). Reduce the potential for loss of life and human suffering caused by flooding.

3). Provide a flood damage reduction plan that is locally acceptable and compatible with local flood protection efforts.

4). Minimize adverse environmental effects.

ALTERNATIVE FLOOD WARNING SYSTEM IMPROVEMENTS

There are a number of considerations to be made in developing the appropriate flood warning system. Factors such as technical feasibility, system sophistication, cost of implementation, ease of operation, reliability, maintenance of the system, and desires of the local community are all important considerations when developing a system.

Listed below are improvements to the existing system identified as having the potential for implementation. Each will be discussed in the following pages.

1). Installation of a base station within the City of Harrisburg.

2). Implementation of an improved flood warning dissemination system.

3). Flood stage forecast model.

4). Integration of the flood warning system into the IFLOWS network.

5). Installation of an additional rain gauge within the lower Paxton Creek basin.

6). Installation of solar panels on all existing and proposed gauges.

Installation of a Base Station within the City of Harrisburg. A base station is critical to the continued operation of the existing system. The removal of the existing computer as part of the relocation of the MARFC will necessitate a new base station be implemented to ensure the continued operation of the existing automated system. The base station will also significantly increase local participation in flood threat recognition. They will have immediate access to the available precipitation and stream data, thereby decreasing the time for flood threat recognition (and increasing the available flood warning time).

The proposed base station (comprised of a personal computer, antenna, receiver, and decoder, and appurtenant components) will be located in an existing building occupied by the City of Harrisburg. The occupants of the building, located at 123 Walnut Street in downtown Harrisburg, include the city's police, fire, and emergency management functions and activities. Data transmitted by the precipitation and stream gauges will be received via an antenna installed on the roof of the building. A hardwire from the antenna will be routed through an existing conduit and connected to a receiver/decoder device. This device processes the radio signal allowing it to be stored and utilized by the base station computer. The base station computer will operate using IFLOWS software. The software will be provided by MARFC.

Specifically the base station is comprised of a VHF antenna (mounted to tripod base affixed to the roof), antenna cable (1/2 inch LDF 450, approximately 100 feet in length), VHF/UHF radio receiver, decoder, base station computer (IBM PS-2 compatible, 386SX, 16HMz, 30 MB hard drive, 2MB RAM), VGA color monitor (12 inch minimum), printer, and appurtenant equipment.

Implementation of an Improved Flood Warning Dissemination System. Three separate methods of improving the existing flood warning dissemination mechanisms were examined; improving the existing phone dialing system, providing beepers to all flood plain occupants, and contracting a private service to provide flood warning. Improving the existing phone dialing system would involve the installation of additional telephone lines in order to place a greater number of simultaneous warnings. Given the relatively short time frame, in which warnings can be effectively issued, a large number of lines would be required. Furthermore, personnel and time required to generate this warning mechanism would be more efficiently spent concentrating on remaining emergency activities. This method was not considered further due to technical, economic, and operational constraints.

Providing telephone beepers (pagers) to all flood plain occupants was also considered. Once the flood threat has been recognized, a single telephone call could alert every beeper holder. The beeper would display a number known to the flood plain occupant as a flood warning. This mechanism would result in the concurrent notification of all flood plain occupants. However, the reliability of this mechanism would require that the beeper be readily accessible at all times to owners/managers of the establishments in the flood plain. Given the potential infrequency of flood events and human nature, it is probable that beepers would become misplaced or forgotten. This method was not considered further due to reliability considerations.

The method determined to be the most efficient, which combines the positive attributes of concurrent warnings to a large number of individuals, reliability, and requires little manpower during times of a flood threat, is the utilization of a private telecommunications service. A private telecommunications service will assist communities (and other groups and organizations) in notifications, using state-of-the-art technology to contact people quickly. Emergency management officials for contacting people in a targeted area or on a specified list would use this tool with telephone calls providing critical information. The services can be used to notify and inform the public concerning various situations, hazardous and radioactive material spills, jail breaks, severe weather (hurricanes), emergency personnel notifications, industrial accidents, military mobilizations, nuclear incidents, and flooding.

Using a series of computers, a pre-established database, and recorded messages, the service rapidly and efficiently contacts and informs the target individuals by telephone of a flood threat. A database will be developed of the flood plain occupants, emergency management officials, and local media to be notified once the decision to issue a flood watch or warning is made. The notifications proceed only at the direction of local emergency management officials. By using the private communications service, warning dissemination time is significantly reduced. Furthermore, the flood warning dissemination service will eliminate the need to use EOC personnel for contacting flood plain occupants, allowing them to concentrate on other flood activities. This service is proposed as part of the improvement to the existing flood warning system.

Flood Stage Forecast Model. The National Weather Service has developed two models, which have application to the Paxton Creek basin. The first model, called the Urban Runoff Model, was created at the Mid Atlantic River Forecast Center. This model is a personal computer based program which utilizes the Horton Infiltration Method to estimate rainfall losses for three types of soil conditions (low, moderate, and high infiltration capacities), assumes the watershed has 70 percent impervious land areas, uses a constant loss rate of 0.02 inches per hour for depression

storage on impervious areas, and employs the Santa Barbara Unit Hydrograph Method to determine runoff from the watershed. The model requires the user to estimate and enter into the model, the time of concentration for any rainfall event. The resultant hydrograph is very sensitive to the time of concentration entered. Furthermore, the accuracy of the stage-discharge relationship, which is based on a regression equation, is limited for the lower end of the stage-discharge range.

The second model was created by the Ohio River Forecast Center. The Flash Flood Hydrologic Forecast Model (ADVIS) is a smaller version of hydrologic forecast models used in many of the National Weather Service Forecast Centers. The ADVIS has the capability of producing a forecast hydrograph based on incremental rainfall (observed or predicted), a one-hour unit hydrograph, and an index (flash flood guidance issued daily by the MARFC). In addition, the beginning creek stage is entered as input into the model. The program generates a forecast hydrograph for the Chromalloy gage. The program can plot the stage hydrograph, display critical stages and present significant high stages and their dates of occurrence.

Based on a review of the results of the ADVIS program in comparison to observed stage hydrographs, the use of a unit hydrograph does provide predictive capability. This capability will reduce the time required for flood threat recognition. In addition, it should be noted that the capability of the model to forecast flood stages with predicted or hypothetical rainfall amounts will allow the user to forecast several "what if" scenarios based on various rainfall amounts. This type of exercise can be accomplished prior to a potential flood event, reducing further the time required for flood threat recognition.

The ADVIS model is proposed to be a component of the improved flood warning system. The advantages of ADVIS are its predictive capability, relatively user-friendly operation, and its availability at no cost (MARFC will provide software at no charge). However, ADVIS does have limitations. The predictive capability of the model is not 100% accurate. During most storm events, the model has predicted runoff of about 30% greater than that, which was observed. This tendency for overprediction must be understood and accounted for by the user of the system. In addition, although the model is relatively simple to use, it will require the training of the personnel responsible for monitoring the system.

IFLOWS Network. The improved flood warning system was considered for integration into the existing IFLOWS network. IFLOWS (Integrated Flood Observation and Warning System) is a joint venture between Federal, State, and local governmental agencies, whose purpose is to provide access to real time precipitation and stage data to Federal, State and local officials to be used for making timely decisions to respond to potential flood threats. Initially developed by the National Weather Service for use in Appalachia, the system has expanded to include parts of Pennsylvania. The system is a joint venture among the National Weather Service (NWS), the Pennsylvania Emergency Management Agency (PEMA), and participating counties. Data is transmitted via radio from the precipitation and stream gauges where it is received by participating counties, and retransmitted to the NWS and PEMA through an existing satellite communications network. PEMA requires that the designated IFLOWS base station computer be operated by a County Governmental Agency. The Dauphin County Emergency Management Agency had expressed a willingness to participate in the IFLOWS network.

Implementation of the IFLOWS network would necessitate the installation of a base station similar to that installed in the city building, (including antenna, receiver/decoder, computer, and appurtenant devices). The site for the base station was identified at the office of the Dauphine County Emergency Management Agency in downtown Harrisburg. The computer software required to operate the network is provided by the MARFC.

Having the system integrated into the IFLOWS network would provide access to the relevant data by the County as well as the MARFC. This gives the system greater reliability, i.e., back-up capabilities. In the unlikely event the data goes undetected by the City of Harrisburg, the County as well as the MARFC, who are monitoring the data concurrently, can inform city officials of a pending flood threat. Given the increased reliability and dependability of the system on IFLOWS, the argument can be made that the time required for flood threat recognition will be kept to a minimum, allowing for the greatest flood warning time available.

Another component considered as part of an improved project, was a hardwire connection between the base stations housed within the City and County buildings. This would provide another level of back-up capabilities. In the event any one antenna, receiver/decoder or base station computer becomes inoperative, data can be transmitted via the hardwire to the disabled system, allowing for the continued monitoring of the data by all interested parties. The hardwire would be routed through an existing conduit between the two buildings, a distance of approximately 775 feet. The connection would require a IBM PS-2 compatible dual async adapter for each base station computer.

The integration of the flood warning system into the IFLOWS network will not be a proposed project component. The City of Harrisburg will not agree to provide the non-Federal share of the total project cost for the base station to be included within Dauphine County. Therefore, integration of the system into the IFLOWS network is prohibited.

Additional Rain Gage. The addition of a third rain gage in the Paxton Creek basin is desirable, particularly in the more critical lower sub-basin. The purpose of the rain gage is two-fold. The first is the collection of additional data, and secondly (and more important) is in the event one of the rain gages should fail, the other would act as a backup. The gage is required for a complete and dependable flood warning, and adds to the systems capability of reducing the amounts of time required for flood threat recognition thereby increasing the amount of flood warning time.

The proposed rain gage will be located on the site of a water treatment plant within the boundaries of its security fence. The treatment plant is located near the intersection of Pine and 17th Streets in Harrisburg, which is approximately one mile in a northeasterly direction from the existing rain gage near the Chromalloy plant. The new gage is described as an automatic tipping bucket gage with a data radio transmitter, VHF antenna, cable, and VHF synthetic transceiver, and appurtenant equipment.

Solar Panels. Solar panels, attached to the existing rain gages and the existing stream gage, are proposed as a measure to increase system reliability and reduce the need for required maintenance (replace or recharge batteries). Installation of the solar panels will include the solar panel, cable, and appurtenant equipment.

ECONOMIC ANALYSIS

Existing Flood Damages. Economic investigations and analyses of the study area were conducted. As part of these activities, a field survey was undertaken. The survey was conducted from the downstream confluence with the Susquehanna River to the upstream limit of the study area near Harrisburg Area Community College. The data collected included; the number and types of affected property, location, first floor and zero damage elevations, value of contents, stage-damage data for contents, and the number of vehicles in parking lots.

Within the study area, there are an estimated 100 commercial and industrial establishments (some with multiple buildings) which are subject to inundation from flooding within the Paxton Creek basin. The structures are located along what is known as the Cameron Street Corridor. The development includes such operations as wholesale and retail trade, service and financial establishments, and manufacturing operations. Many of the structures are brick or other masonry construction with two stories. Other buildings, which are subject to inundation, include the Harrisburg Area Community College (10 structures) located near the upstream limits of the study area, Downey Elementary School located on 1313 Monroe Street, and an apartment complex (11 buildings) located on the corner of Cameron and Calder Streets. Both the elementary school and the apartment complex are situated within the Cameron Street Corridor. Within the flood plain are also a number of vacant and/or unidentified buildings.

Existing flood damages were computed for two major damage categories; industrial and commercial building contents and motor vehicles. These categories have the greatest potential for flood damage reductions as a result of an improved flood warning system. Damages to structures within the flood plain were neither quantified nor evaluated since a flood warning system will have little impact on the reduction of this type of damage. Existing damages were not computed for the Harrisburg Area Community College, Downey Elementary School or the apartment complex because it was judged that they would have little impact upon the amount of total damages computed for the study area.

The overall study area was divided into four reaches on the basis of significant concentration of damageable property, and the availability of hydrologic and hydraulic data. Table 2 below defines the damage reaches.

TABLE 2
DAMAGE REACHES

Reach Number	From	To	Location of Hydraulic Rating Curve
1	Elmerton Avenue	Calder Street	Calder Street
2	Calder Street	Downstream of CAT*	Herr Street
3	Herr Street	Berry Mill Street	Mulberry Street
4	Berry Mill Street	U. S. Route 83	Paxton Street

*Capital Area Transportation Building

The depth of flooding for each identified structure was evaluated by determining the stage for each reach and the zero damage elevation associated with each structure. Frequency-stage data was evaluated for the 2, 5, 10, 25, 50, 100, 200, and 500-year events.

Existing average annual damages for commercial and industrial contents were estimated on the basis of a sample of 20 properties that were interviewed. Stage-damage and stage-frequency curves for each flood damage reach were related to develop appropriate frequency-damage curves. The resultant frequency-damage curves were integrated to estimate damages on an average annual basis. Based on the existing average annual damages computed for the sampled properties in each reach, an average amount per property was developed and applied to the remaining structures. Based on the process described above, estimated total average annual damages for commercial contents are $2,487,000. For the purpose of determining damages for vehicles it was necessary to distinguish company vehicles from employee vehicles. As previously mentioned a site survey was conducted to determine the number of motor vehicles in flood plain parking areas, the number of employee vehicles and company vehicles, average vehicle values, and the average elevation of parking areas. It was estimated that between 700 and 800 vehicles are located in the flood plain during normal business hours. For employee vehicles, average auto values was assumed to be $5,000 per vehicle (a conservative estimate), and the average elevation of parking areas as minus three feet relative to the first floor elevation of the structure. A depth-damage curve was applied to determine expected value of damage at selected flood frequencies. Vehicles were assumed to receive maximum damage at flood depths of four feet (80% of value). For company vehicles, which are typically larger than employee vehicles, the depth of flooding required to cause a given percent damage was one foot greater than that for employee vehicles. Using actual estimates from the survey interviews derived company vehicle values. To account for the length of time vehicles are assumed to be at risk of being flooded, computed stage-damages were multiplied by the proportion of time vehicles are parked in the flood plain. Since company vehicles travel in and out during the normal working hours, and are usually parked in the flood plain the remaining sixteen hours, damages were multiplied by two-thirds. Similarly, damages to employee vehicles were multiplied by one-third. Total estimated average annual damages for motor vehicles are $83, 000.

Table 3 displays the total existing average annual damages by reach and category.

TABLE 3
EXISTING AVERAGE ANNUAL DAMAGES

Number	Contents	Vehicles	Total
1	$ 292,000	$30,000	$ 322,000
2	$ 465,000	$11,000	$ 476,000
3	$1,692,000	$37,000	$1,729,000
4	$ 38,000	$ 5,000	$ 43,000
TOTAL	**$2,487,000**	**$83,000**	**$2,570,000**

Flood Warning Time. The estimated time of concentration is between 1 and 1.5 hours, based on the characteristics of the basin and an examination of the appropriate hydrographs.

There is no reliable flood threat recognition mechanism under the most likely future conditions. Given the lack of a base station, real time monitoring of rainfall and creek stage is not possible. Reliance on observed rainfall and data received from the manual gage (near Chromalloy) will not provide accurate and timely data from which to evaluate and recognize a flood threat until such time that inundation is imminent or occurring. Although the existing flood warning dissemination mechanism (manual phone dialing) is operational, given no flood threat recognition is possible, the existing time (estimated at 35 minutes, or the time to contact 103 occupants at four simultaneous calls per minute) required for warning dissemination is moot. It is assumed that if a flood warning were disseminated, the response (i.e., actions by flood plain occupants and local officials) would be immediate.

The proposed improvement (comprised of the installation of a base station within the City of Harrisburg, utilization of a flood warning dissemination service, utilization of a flood stage forecast model, an additional rain gage, and the installation of solar panels on all gages) will have the capability for flood threat recognition as a result of the ability to observe, in real time, the amount of rainfall and the creek stage, as well as utilization of the flood forecast model.

Flood threat recognition is estimated to be accomplished within 30 minutes of the end of significant rainfall. Within this time, the user will be alerted to a potential flood threat by evaluating the amount and intensity of rainfall, and the level or rate of increase in creek stage, either by monitoring the incoming data or through the pre-determined alarms (audible and visual signals which are activated on the IFLOWS software). With experience in operating the system and evaluating the incoming data, the user will gain knowledge on the hydrologic response of the basin and be able to recognize potential flood threats. Generally, heightened awareness (constant monitoring of incoming data, determination of rate of increase in creek stage, intensity of rainfall, likelihood of continued rainfall) of the potential flood threat should commence immediately whenever creek stage exceeds 7 feet. Similar to NWS procedures, at a stage of 10 feet when rain is expected to continue, a flood warning should be disseminated. Flood threat recognition is enhanced with the utilization of the flood stage forecast model. Because the forecast is for all practical purposes known immediately after the appropriate parameters (including observed or hypothetical rainfall) have been input into the computer model, this data can also be evaluated in the determination of a flood threat as well as give an indication of the peak flood stage. These two activities can be conducted concurrently.

Once the flood threat is recognized, the decision to issue a flood warning needs to be addressed. Factors to consider in disseminating a warning is the perceived likelihood of flooding, the extent of anticipated flooding, and the potential for a false alarm. Once the decision is made to issue a flood warning, the flood warning dissemination service is contacted. They in turn disseminate the flood warning. The total time for flood warning dissemination is estimated at 6 minutes, based on 4 minutes to contact service and initiate warning and 2 minutes to disseminate warning (103 calls, with 55 simultaneous calls per minute). It is assumed that if a flood warning is disseminated, response (i.e., actions by flood plain occupants and local officials) would be immediate.

Table 4 displays a comparison of flood warning times between the without and with projected conditions.

TABLE 4
FLOOD WARNING TIMES)
(Hours)

	Without Project	**With Project - Improved Conditions**
Time of Concentration	1.0 - 1.5	1.0 - 1.5
Flood Threat Recognition Time	*	0.5
Warning Dissemination Time	0.6	0.1
Flood Warning Time	**	0.40 - 0.90

* Accurate and timely flood threat recognition unlikely under the most likely future conditions.

**Most likely future conditions will not provide time for response to a flood warning.

Warning Time Damage Reduction Relationship. In order to evaluate the economic benefits of a flood warning system, the relationship between warning time and the value of expected flood damages prevented (by removing or relocating flood damage prone contents and vehicles, and evacuations) must be defined. It is expected that the greater the flood warning time, the greater the reduction in flood damage.

During the field survey of the flood plain previously discussed, owners and managers of commercial or individual property were asked what actions they would take to reduce flood damages if given 15, 30, 45, or 60 minutes of flood warning time. This data obtained from the interviewed properties was applied to al the commercial and industrial properties to arrive at a aggregated warning time-damage reduction relationship.

Table 5 displays the warning time-damage reduction relationship

TABLE 5
WARNING TIME-DAMAGE REDUCTION RELATIONSHIP

I. COMMERCIAL CONTENTS			
Warning Time (minutes)	**Percent Damage Reduction**	**Existing Average Annual Damages**	**Average Annual Damages Prevented**
15	0	$2,487,000	$ 0
30	7	$2,487,000	$174,000
45	14	$2,487,000	$348,000
60	25	$2,487,000	$622,000
II. MOTOR VEHICLES			
Warning Time (minutes)	**Percent Damage Reduction**	**Existing Average Annual Damages**	**Average Annual Damages Prevented**
15	32	$83,000	$27,000
30	35	$83,000	$29,000
45	42	$83,000	$35,000
60	47	$83,000	$39,000

Average Annual Benefits. Benefits attributable to the improved flood warning system are the result of an estimated increase in flood warning time between 25 and 55 minutes. Based on an interpolation of the relationship shown in Table 5, average annual benefits for commercial contents is estimated between $116,000 and $531,000. Average annual benefits for motor vehicles is estimated to be between $28,500 and $37,500 for 25 and 55 minutes of warning time respectively.

There is some uncertainty over the potential for achieving motor vehicle damage reduction benefits. The feasibility of successfully evacuating the large number of motor vehicles via Cameron Street in the time frames permitted by the proposed flood warning system could not be determined. Therefore only those benefits attributable to the reduction in damage to commercial contents will be used in the benefit-cost ratio analysis.

ESTIMATION OF PROJECT COSTS

Total project costs include lands, easements, and rights-of-way; project features, planning, engineering, and design; and implementation management. Total project costs are converted to equivalent average annual costs by amortizing the investment over a 20-year project economic life using the Federal discount rate of 8 1/2%. The resultant factor is 0.105671. The average annual project cost plus annual operation and maintenance costs, as well as replacement costs, equal the total average annual project cost. Table 6 displays the components of project first cost and average annual costs.

TABLE 6
PROJECT COSTS AND AVERAGE ANNUAL COST

Lands	**$ 500**
Project Components:	
Rain Gage	$ 7,400
Base Station	$ 25,600
Flood Warning	
Dissemination Service	$ 53,600
Solar Panels	$ 2,000
IFLOWS Software	$ 0
Flood Forecast Model	$ 0
Subtotal Components	$ 8,600
Planning, Engineering, and Design	$ 21,500
Contract Activity	$ 5,000
Implementation Management	$ 5,000
Total Project Cost	$129,200
Interest and Amortization	$ 12,700
Operation and Maintenance	$ 2,200
Replacement	$ 800
Total Average Annual Cost	**$ 15,700**

Since the land required for project implementation is currently owned by the City of Harrisburg, no financial cost of land is associated with the project, hence it is not included in the detailed cost estimate. However the $500 reflects an economic cost based on the market value of the land, and must be included in total project costs for the purpose of the benefit-cost ratio analysis and cost sharing.

Replacement costs will be incurred during the life of the project. Given that existing gages will be incorporated into the improved project, those gages will exceed their physical life of the improved system. Specifically, the two existing rain gages and the existing stream gages can be expected to need replacing during the 20-year project life. Therefore these gages, installed in 1984, will require replacement in the year 2003 (assumes existing gages also have 20 year economic life.) The project cost of these replacements are the present worth value of those costs expected to be incurred in the year 2003. They are computed using the appropriate present worth factor (8-1/2%, 10 years) of 0.44229. The resultant present worth value is then amortized over the life of the proposed improvement. The computation of replacement cost is shown below.

TABLE 7
REPLACEMENT COSTS

Project Component	Total Cost	Present Worth Factor	Replacement Cost	Interest and Amortization
Rain Gage (2)	$13,200	0.44229	$5,800	$600
Stream Gage	$ 5,000	0.44009	$2,200	$200

The operation maintenance costs associated with the proposed improvement include the preventive maintenance required for the rain stream gages. These annual costs are estimated at $1000.

The flood warning dissemination service will result in a total estimated annual maintenance cost of $1,200, which includes $1,000 for periodic updating of the data base of flood plain occupants, and $200 in the event the service is notified to disseminate warning, a user charge of $60 per hour of computer calling time is assessed (it is estimated that 3 hours of computer time will be required to disseminate 103 warnings). Total annual operation and maintenance costs are $2,200.

Table 8 displays the summary of the benefit-cost ratio analysis. Average annual benefits used in this analysis are based on a conservative flood warning time of 25 minutes.

TABLE 8
BENEFIT-COST RATIO ANALYSIS

Average Annual Benefits	Average Annual Costs	Benefit-Cost Ratio	Net Benefits
$116,000	**$15,700**	**7.4**	**$100,300**

NATIONAL ECONOMIC DEVELOPMENT PLAN

This plan is the one, which maximizes net benefits, consistent with protecting the nation's environment. Although the national economic development plan is typically identified from various identified alternatives, the proposed flood warning system developed reflects the limited number of improvements to the various components of the system available for implementation. Since each identified individual improvement is required to produce a complete and reliable system, a smaller less costly project (for instance one without the flood warning dissemination service) will not function in a manner for which it is intended, i.e., will not provide an adequate flood warning. Hence potential flood damage reduction benefits will go unrealized. On the other hand, a larger more costly project (for instance, one with additional rain or stream gauges) will not result in increased system performance or project benefits. The proposed flood warning system is considered the only alternative, which provides a complete and effective improvement, while at the same time maximizing flood damage reduction benefits. Therefore, it is considered the national economic development plan.

ENVIRONMENTAL EFFECTS

Environmental Resources. Presently, no wildlife habitat or wildlife exist on the proposed rain gage location due to the ongoing construction activities for the Harrisburg water treatment plant. Once the construction is complete, the property will be predominately a manicured lawn with formal landscaping.

The proposed rain gage site is presently disturbed and has been altered by ongoing activities (i.e., grading, placement of utility lines, and road construction and realignment) related to the construction of a water treatment facility by the City of Harrisburg. A mature stand of eastern deciduous forest and steep slopes border all sides of the property, with the exception of the southwest side which is moderately sloped and used for industry. Asylum Run, which drains into Paxton Creek, flows along the northeast border of the property, through the eastern deciduous forest.

The construction actions for a rain gage on any of the three proposed alternative locations would be minor, temporary, and localized. All impacts associated with the construction actions are not considered significant to the environment. This is primarily due to the limited amount of construction effort required to install the rain gauge and the existing disturbed condition of the proposed rain gage locations.

The construction of the rain gage and the rain gage itself, would not displace any habitat or wildlife species since the proposed rain gage locations are already disturbed from ongoing construction activities, and due to the relatively small size of the rain gage. Additionally, no

threatened or endangered species occurring in the overall Paxton Creek study area would be affected.

None of the remaining proposed project features involve what is typically considered a construction activity. The installation of electronic equipment (and associated computer software) within existing structures will not result in the disturbance of environmental resources. Therefore, the implementation of the remaining proposed project features will have no impact upon the environment.

Cultural Resources. In accordance with Section 106 of the National Historic Preservation Act of 1966 and its implementing regulation, 36 CFR 800, Protection of Historic Properties, a cultural resource investigation was conducted for the proposed rain gage locations. There are no known cultural resources recorded for the site, and a pedestrian field survey conducted for the site found no cultural resources. In accordance with 36 CFR 800.4(d), the Corps has provided documentation of this finding to the State Historic Preservation Officer, and is not required to take any further steps in the Section 106 process.

PLAN ACCOMPLISHMENTS

The proposed alternative evaluated in this document was formulated with the intent of achieving the planning objectives as described previously. The proposed alternative addresses each of the stated planning objectives, including the reduction in economic losses as a result of flooding, reducing the potential for loss of life and human suffering caused by flooding, is locally acceptable and compatible with existing local flood protection efforts, and minimizes any adverse environmental effects.

As a result of the proposed alternative, flood threat recognition is significantly improved. The City of Harrisburg will have the ability to monitor rainfall and creek stage on a real time basis. Hence the time required for flood threat recognition is greatly reduced. In addition, the flood forecast model can be utilized to anticipate the extent of flooding. Warning dissemination time is also greatly reduced, allowing additional warning time for flood fighting measures and evacuation. The solar panels will result in less required maintenance, while the additional rain gage will improve system reliability.

VERMILION RIVER BASIN
LAFAYETTE PARISH, LOUISIANA

INTRODUCTION

The United States Army Corps of Engineers, New Orleans District, is investigating measures to reduce flood damages in Lafayette Parish, Louisiana from flooding along the Vermilion River. The Vermilion River is the major drainage artery in Lafayette Parish and originates near the Lafayette and St. Martin Parish northern boundary. During favorable tidal conditions and river stages, the Vermilion River captures the runoff from many intersecting channels, and conveys the flow to Vermilion Bay, ultimately flowing into the Gulf of Mexico. During high tides, high stages of the Vermilion River, and intense storm events, the flow direction reverses and overtops the riverbanks. This results in flooding to residential areas.

Congress has authorized the Corps of Engineers to conduct a feasibility study of protecting Lafayette from flooding. This study – the Lafayette and St. Martin Parish Comprehensive Flood Damage Reduction Study – is expected to take several years to complete. In the interim, Congress has authorized the Corps to study non-structural measures to protect some residential areas that 1) experience frequent flooding and 2) may not be adequately protected by the structural solutions proposed by the large study.

Three areas are being considered for non-structural flood control protection and are described below:

Area No. 1. This area consists of Demande Park Subdivision, Demande Park Subdivision Extension #1, and Eastdale Subdivision Extension #1. North Demanade Boulevard, Teche Drive, Mae Drive, and the Vermilion River bound this area.

Area No. 2. This area consists of the Bendel Gardens Subdivision. It is bounded by South College Road, West Pinhook Road, the Vermilion River and Coulee Mine.

Area No. 3. This area consists of the Bois de Lafayette Subdivision. It is bounded by Flossmore Drive, Wentworth Boulevard, Acacia Drive and the Vermilion River.

EXISTING PROTECTION

Areas 1, 2, and 3 currently do not have protection from flooding.

SOCIO-ECONOMIC IMPACTS

Nearly 495 claims totaling about $5.3 million in losses to structures and contents were filed with FEMA after the flood of 1993. Not included in this assessment of damages were vehicle flooding, uninsured property losses, reduction in property value due to repeated structural and street flooding, disruption of business activity, costs of evacuation and other emergency operations borne by the communities, cost of Federal disaster assistance, Federal Insurance Administration (FIA) administrative costs for processing claims, and losses to public infrastructure such as roads and bridges.

Summary of Expected Flood Damages. Table 1 synopsizes the values of the structures, contents and cars in the areas of potential flooding. Flooding would begin once water reached the structure's first floor elevation or to a depth of 1.0 ft for cars.

TABLE 1: VALUE OF STRUCTURES, CONTENTS AND CARS

AREA	NUMBER OF STRUCTURES	VALUE OF STRUCTURES	VALUE OF CONTENTS	VALUE OF CARS	TOTAL VALUE
Area 1	70	$13,076,443	$8,499,688	$1,505,980	$23,082,112
Area 2	28	$3,968,171	$2,579,311	$473,308	$7,020,790
Area 3	33	$4,490,893	$2,919,080	$709,962	$8,119,935

Damage Evaluation. The structures potentially affected by flooding in each area were compared to the stages generated by the hydraulic analysis. The depth-damage relationship used in this study was developed by a panel of experts as part of the Jefferson/Orleans Parish Feasibility Studies. These curves were based on detailed damage surveys of selected residential and nonresidential properties in Jefferson and Orleans Parishes in the State of Louisiana. Each unit was visually inspected with estimated expected damages recorded at various levels of inundation. Structure types, structure value, and type of flooding differentiated these curves. Since the range of structure types in the Lafayette Parish area is virtually identical to those found in the Jefferson-Orleans study area, use of these data are appropriate.

Table 2 shows the cumulative number of structures damaged by flood frequency in each of the study areas.

TABLE 2: CUMULATIVE NUMBER OF STRUCTURES DAMAGED WITHOUT PROJECT CONDITION

Flood Interval	1-Yr	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr	200-Yr	500-Yr
Area 1	0	0	0	4	17	32	49	62	69
Area 2	0	0	2	5	5	9	13	17	21
Area 3	0	0	0	0	0	3	16	24	29
Total Flooded	0	0	0	9	22	44	80	103	119

With the exception of one structure in Area 3, all of the structures are single family residences.

PLAN FORMULATION

This section describes the process of developing plans to address the flood protection needs of the study area.

INITIAL PLAN DEVELOPMENT

The Guidance for Conducting Civil Works Planning Studies (ER 1105-2-100) requires the systematic development of alternative plans that contribute to the Federal objective. The objective of this study is the development of an economically feasible and environmentally acceptable flood protection plan that would enable the three areas to adequately withstand a 100-year rainfall event without substantial residual flooding.

Non-structural alternatives were considered to address the problems and needs relative to rainfall flooding within the study area. Non-structural alternatives were limited to levees, floodwalls, structure raising and dry floodproofing. Structural alternatives for the Lafayette and St. Martin Parish are being considered under a separate study.

Development of non-structural alternatives to provide flood protection in Areas 1, 2, and 3 was based on recommendations made in a feasibility study by the New Orleans District in the Lafayette and St. Martin Parish Comprehensive Flood Damage Reduction Study prepared in June 1995.

Economic Benefit

The National Economic Development Procedures Manual for Urban Flood Damage recognizes four primary categories of benefits for urban flood control plans: inundation reduction, intensification, location and employment benefits. Inundation reduction is the only category of NED benefits for urban areas considered in this analysis. In addition to the reduction in damages caused by inundation, this category also includes the reduction of emergency costs, evacuation and subsistence costs, reoccupation costs, and Federal Insurance Administration costs savings. The evaluation process involved the formulation and assessment of the flood control improvements, the identification of categories of possible flood control benefits, the determination of without- and with-project damages and costs incurred, and standard benefits-cost comparisons.

The values estimated for benefits and costs at the time of accrual were made comparable by conversion to an equivalent time basis using a designated interest rate. The interest rate used in this analysis is 6.875 percent. The period of analysis, or project life, utilized in the analysis is 50 years. The benefits and costs are expressed as the average annual value of the present worth of all expenditures and all plan outputs. The base year for this project is 2001, which represents the year in which the project becomes operational or when significant benefits start to accrue.

Plan Assessment and Evaluation

A detailed analysis was performed which concentrated on areas of the community that experienced the highest level of repetitive damage due to flooding. These areas were identified during the coordination, public involvement and engineering portions of the 1995 Feasibility Study.

No Action. Under this alternative, the Corps of Engineers would not participate in protecting Areas 1, 2, or 3 from flooding under this authorization. The communities would experience

repeated flooding at least until the comprehensive study for Lafayette and St. Martin Parish was completed and the project elements implemented.

Non-Structural Alternatives. Floodwalls, levees, structure raising and dry flood proofing were determined to be the best solution to protect the residents in Areas 1, 2, and 3. Buy-outs and relocations were considered and deemed not to be feasible based upon associated costs.

ENVIRONMENTAL EFFECTS WITH PROJECT IN PLACE

The study team analyzed the environmental impacts of structure raising and dry floodproofing of selected homes in Areas 1, 2, and 3. The Environmental Assessment discusses the environmental impacts of the alternative. A brief summary is provided in this section.

WATER QUALITY

Because only structure raising or floodproofing is proposed, no effects to water quality are anticipated. Erosion control will be practiced at each home modification to control turbidity effects to the Vermilion River.

NPDES legislation requires a Pollution Prevention Plan (PPP) for each project in order to reduce contamination in the waterways due to the construction process. Often included in the PPP are temporary and permanent controls such as hay bales, silt fences, sedimentation ponds, vehicle washing racks, and seeding and mulching denuded areas. The effects of construction are temporary and would subside when construction stops and denuded areas are restored. Water quality after completion of the project should be similar to the existing water quality.

VERMILION RIVER

With implementation of the proposed action, structures currently in the 100-year floodplain in Areas 1, 2 and 3 would be protected from the 100-year flood event. Since the areas to be protected are structures which would be raised or dry flood proofed with a minimal increase in foot print, the proposed action would have a negligible effect on the river.

WETLANDS

Since there are no known wetlands in Areas 1, 2, and 3 and the impacts of the proposed action are minimal and mostly short-term, there will be no adverse effects to wetlands in Areas 1, 2, or 3.

FORESTED HABITAT

If the project were implemented, some urban habitat such as trees, shrubs, and yards would be impacted.

WILDLIFE

If the project were implemented, the biological resources of the area would not be affected and would continue to exist as urbanized biological communities.

ESSENTIAL FISH HABITAT

According to the National Marine Fisheries Service, there is no essential fish habitat in the project area. Therefore, it is unlikely that this proposed action would have an adverse effect on essential fish habitat.

ENDANGERED OR THREATENED SPECIES

Since there are no known threatened or endangered species in Areas 1, 2, and 3 and the impacts of the proposed action are minimal and mostly short-term, the proposed action would not adversely affect threatened and endangered species, nor adversely modify or destroy critical habitat for such species.

CULTURAL RESOURCES

Areas 1, 2 and 3 are non-structural projects. Selected homes in each area will be dry-floodproofed and/or raised. No floodwalls, ring levees or channel improvements are planned. Homes in these areas are less then 50 years old. It is highly unlikely that cultural resources will be affected by these projects; thus, no future cultural resource investigations are warranted.

RECREATIONAL RESOURCES

There would be no impacts to any recreational resources resulting from the proposed action.

AIR QUALITY

The proposed action would cause some emissions from construction equipment. These emissions would be localized, minimal, and short term.

CUMULATIVE IMPACTS

Cumulative effects would include minor losses in habitat. The habitat to be lost is already degraded by development and likely would be further degraded by future development. The loss of wooded habitat by the proposed action would be minimal and long-term. Replanting would restore some of the forested component to the temporary construction areas. Overall, the cumulative impacts of the proposed action are minimal when compared to the losses due to the continued development in the area.

DETERMINATION OF THE RECOMMENDED PLAN

This section evaluates the NED results for each plan developed separately in relation to the no-action plan. The NED plan is defined as the plan that most reasonably maximizes net tangible economic development benefits. This is the difference between equivalent annual benefits and average annual costs, consistent with the Federal objectives

Area 1. In Area 1, 49 homes flood during a 100-year storm. Several options for providing flood protection were initially considered. Based on conceptual layouts and estimates, including discussions with study area residents and Lafayette City/Parish officials, the following options were selected for further development in the feasibility stage.

A sheet pile floodwall would be constructed along the west bank of the Vermilion River. The top of the floodwall would be set at the 100-year floodplain elevation plus 2-foot of freeboard (17.00 + 2.00 = 19.00). The north and south ends of the floodwall would be terminated at existing grade elevation at 19.00 ft minimum. The existing runoff from the study area, currently discharging into the Vermilion River, would be diverted to two new pumping stations. The runoff would then be pumped over the floodwall back into the river. A portion of the existing flows above elevation 19.00 (on North Demande and Teche Drives) would be diverted around the study area to reduce the volume of runoff that would have to be pumped. In addition, a new subsurface drainage system would be constructed behind the homes bordering the Vermilion River and parallel to the new floodwall to drain the backyards that currently drain overland directly into the Vermilion River, but would now be blocked by the new floodwall.

The annual cost of protecting Area 1 from flooding is $201,535 (Table 3). This includes $15,000 for operations and maintenance, but excludes any costs for real estate acquisition or environmental mitigation.

TABLE 3: ANNUAL COSTS – AREA 1 FLOODWALL

First Costs	$ 2,615,584
Real Estate	$ N/A
Mitigation	$ N/A
Total First Costs	$ 2,615,584
Average Annual Costs	$ 186,535
Operation and Maintenance	$ 15,000
Total Average Annual Costs	$ 201,535

A second option would be to raise or floodproof potentially affected homes in Area 1. To raise a home, the slab must first be excavated. Into the excavation two longitudinal steel I-beams and several cross members must be inserted. Next, the plumbing connections as well as any support connections to the house must be severed. Under the beams and members self-leveling hydraulic jacks are inserted. Then the slab is raised to the required grade. To avoid internal and external cracking of the slab, the structure must be raised uniformly. Generally numerous jacks are used to minimize that possibility. Once raised, the slab may be supported by piers or the space backfilled (Home, 1999; USACE, 1994; USACE, 1990).

Site conditions, site preparation, mobilization, and the size of the structure primarily affect the total costs for structure raising. The cost to raise a 1300 ft^2 structure ten feet off the ground is approximately $31 per square foot of livable first floor area (USACE, 1990). A second reference (FEMA, 1995) gives a cost of $24 per square foot for a two-foot raise with an additional cost of $0.75 - $1.00 for each additional foot. Costs were adjusted to 1999 dollars (using ENR Cost Construction Index) to maintain consistency with previous reports. The average of the two costs for structure raising to 10 feet is $36.94 per square foot. Adding in design (10percent), profit (10percent), and contingency (10percent), the cost becomes $49.17 per square foot.

There are several techniques to dry floodproof homes. One technique involves coating the house with an asphalt or cement based coating, then applying a brick veneer to maintain the appearance of the house and to protect it from floodborne debris. The other technique consists of wrapping the house with a polyethylene film. Next waterproof stucco is placed over the skin. The stucco is then painted to match the rest of the home or brick facing can be used. Doors that can be made watertight when a flood occurs replace the existing doors or are added on to the structure. In addition, interior drainage lines should be sealed with a backflow, cutoff or check valve to prevent back flooding into the interior of the home (Dalhman, 1999; USACE, 1993; FEMA, 1998).

It takes about a week to ten days to completely waterproof an average home. The cost for floodproofing a house with a slab on grade costs $12 per square foot, including design, profit, and contingency. Mobilization and labor account for a large portion of the costs, thus the height of floodproofing will have little effect on cost (Dahlman, 2000). Since the cost is not proportional to the height of protection, this study assumes that structures receiving floodproofing have 3 feet of protection regardless of the 100-year flood depth. For structures that are floodproofed, damages will occur when flood depths are greater than the protected height. For this study, it was assumed that full damages to structures would occur during these circumstances.

Maintenance is required for dry floodproofing. Back flow valves should be checked annually at a cost of approximately $100 per home. In addition, every five years, sealants should be touched up and all shields checked. This costs $1000 per home (Taylor, 1999). An annual maintenance cost of $300 per home was carried forward in this study.

Dry floodproofing is most effective for brick or brick veneer buildings because of their greater structural strength and ability to withstand hydrostatic forces. Although dry floodproofing is far cheaper than structure raising, there are some disadvantages with the technique. USACE-DCR (1993b) cites several disadvantages:

- Water may seep through the sealant especially when long term flooding occurs.
- Flood protection is limited to a maximum of 3 ft.
- Flood insurance premiums are not lowered.
- Human intervention may be required.
- People may not feel the need to evacuate in an unsafe situation.

Dry floodproofing is not recommended for flood heights above three feet, due to hydrostatic pressure (USACE, 1993). For this study, structures that are flooded up to 2 feet at the 100-year flood event, receive floodproofing with 1-foot of freeboard. Thus floodproofed structures receive a total of 3-feet of protection. For those homes that receive more than two feet of flooding at the 100-year flood event, structure raising is a more appropriate option. The short duration of the flooding experienced make dry floodproofing attractive for this area of Lafayette. The total annual cost for structure raising and floodproofing structures in Area 1 is $253,724.

Area 2. Thirteen homes in Area 2 are subject to flooding during the 100-year storm. Five of the homes suffer from greater than two feet of flooding and are candidates for structure raising. The remaining eight homes suffer from less than two feet of flooding and are candidates for dry floodproofing. The total annual cost for structure raising and floodproofing structures in Area 2 is $58,648.

Area 3. There are 16 homes subject to flooding in Area 3 during the 100-year storm. One of these homes suffers from greater than 2.0 feet of flooding and is a candidate for structure raising. The remaining 15 homes suffer from less than 2.0 feet of flooding and are candidates for dry floodproofing. The total annual cost for structure raising and floodproofing structures in Area 3 is $57,005.

OTHER ECONOMIC BENEFITS OF FLOOD PROTECTION

For any given flooding event the benefit is determined by calculating the difference between the estimated annual average damage with a project alternative in place and the estimated annual average damage under existing conditions. The estimated damages for the existing condition and the with-project condition were determined from the first floor elevation, the depreciated structure value, surface water elevation during flood events, and depth-damage curves.

The economic evaluation, along with considering the reduction in flood damages to structures, their contents, and automobiles from 100-year and more frequent storms, also considered other economic benefits:

- Reduction in annual emergency costs;
- Reduction in evacuation and subsistence costs;
- Reduction in reoccupation costs; and
- Reduction in Federal Insurance Administration (FIA) policy administrative costs.

The cost assumptions for these benefit categories are based on recent experience at comparable flood control projects in the New Orleans District.

Emergency Costs. Emergency costs are the costs of law enforcement overtime, Department of Public Works overtime for placement of barricades and cleanup, and pest and mosquito control overtime. Flood protection would reduce or eliminate these costs. Annual emergency costs are assumed to be $2,300 per flooded structure

Evacuation and Subsistence Costs. Large floods may cause the evacuation of residences and the subsequent payment of subsistence to residents who are required to seek shelter. The flood

protection project would reduce or eliminate these costs. Evacuation and subsistence costs are assumed to be $400 per flooded structure.

Reoccupation Costs. Flooding events may cause homeowners to contract, supervise, and inspect repairs to clean and disinfect their homes. Flood protection would reduce or eliminate such costs. Reoccupation costs are assumed to be $1,570 per flooded structure

FIA Policy Administration Costs. FIA documentation must be prepared by the residents of structures within the 100-year floodplain. Costs include claims adjustments, agent commissions, and policy service. Reduction in annual flood insurance administration costs occurs when homes receive protection from the 100-year storm, and therefore no longer participate in the flood insurance program. The FIA administration costs are assumed to be $140 per participating structure.

Emergency, evacuation and subsistence, and reoccupation costs are assumed to begin occurring at the 10-year storm event. Therefore, the benefit in each of these categories is the reduction in the number of structures flooded under the 10, 25, 50, and 100-year events for the with-project condition when compared to the number of structures affected under the No Action alternative. The reduction in the FIA administrative costs assumed the following participation rates: 100 percent of the structures in the 1,2,5, and 10-year flood zones; 80 percent of those in the 25 and 50-year flood zones; 60 percent of those in the 100-year flood zone.

The benefits for structure raising and floodproofing consider the reduction in damages to automobiles, structures and their contents. Structure raising and floodproofing will not prevent damages to automobiles, thus damages with and without the project represent full damages to automobiles according to the depth-damage curves. Annual emergency costs, evacuation and subsistence costs, and FIA policy administration costs would remain the same with or without the single structure alternatives, thus were not accounted for when floodproofing or structure raising. For an accurate comparison, existing conditions when considering floodproofing and structure rising, does not include automobiles.

Table 4 summarizes the benefits for each area. Two options are considered for Area 1, a floodwall or a combination of floodproofing and structure raising. The only feasible option for Area 2 is the combination of floodproofing and structure raising.

TABLE 4: EXPECTED ANNUAL FLOOD DAMAGES TO STRUCTURES AND AUTOMOBILES

Damage Category	Area 1 Floodwall	Area 1 Raising or Floodproofing	Area 2 Raising or Floodproofing	Area 3 Raising or Floodproofing
Reduction in expected annual property damages	$153,745	$184,540	$99,369	$16,812
Reduction in average annual emergency costs	$5,832	$ -	$ -	$ -
Reduction in average annual subsistence costs	$1,039	$ -	$ -	$ -
Reduction in average annual reoccupation costs	$3,988	$2,573	$1,872	$91
Reduction in average annual FIA administration costs	$5,879	$ -	$ -	$ -
Total Average Annual Benefits	$170,483	$187,113	$101,241	$16,903

ECONOMIC BENEFIT

A benefit-cost summary is provided in Table 5, which represents all of the options for Areas 1,2, & 3. There are two options for Area 1, a floodwall or the combination of structure raising and floodproofing. The only feasible option for Areas 2 & 3 is the combination of structure raising and floodproofing.

TABLE 5: BENEFIT TO COST SUMMARY

	Area 1 Floodwall	Area 1 Raising or Floodproofing	Area 2 Raising or Floodproofing	Area 3 Raising or Floodproofing
Average Annual Benefit	$170,483	$187,113	$101,241	$16,902
Average Annual Cost	$201,535	$253,724	$58,648	$57,005
Benefit to Cost Ratio	0.82	0.74	1.73	0.30
Net Benefits	$(36,639)	$(66,611)	$42,593	$(40,103)

Area 2 is the only area with a BCR greater than 1.0. Area 2 consists of 13 structures that are damaged by the 100-year flood and would require protection.

INDIVIDUAL STRUCTURE ANALYSIS

In order to optimize the benefits for the Lafayette area, and encompass those structures with severe flooding in Area 1 and Area 3, an analysis of each structure and their BCR was conducted. The analysis compared existing condition to structure raising and floodproofing. Average annual costs and benefits were calculated for each structure.

There are twelve structures in Area 1, and four structures in Area 2 with a BCR greater than 1.0. The total cost for raising and floodproofing those structures would be approximately $83,668. Those structures in Areas 1,2, and 3 considered for structure raising with marginal BCRs (BCRs between 0.7 and 1) were evaluated for an optimal height of raising. The costs for varying heights as shown in Table 6, were developed using the previously mentioned costs.

TABLE 6: COSTS FOR VARIOUS HEIGHTS OF STRUCTURE RAISING

Raise (ft)	Cost/sq. ft.
3	$40.59
5	$42.83
8	$46.19
10	$49.17

The marginal structures had the highest BCRs at 5 feet as shown in Table 7. With a 5-foot raise 1204 College has a BCR greater than 1.0.

TABLE 7: BCR FOR MARGINAL STRUCTURES AT A 5 - FT RAISE

Address		5 Ft Const Cost	5 Ft Avg Annual Cost with O&M	5 Ft Avg Annual Benefit	5 Ft BCR
415	E Demanade	$105,193	$7,802	$5,761	0.738
520	E Demanade	$137,273	$10,090	$7,917	0.785
600	E Demanade	$135,560	$9,968	$7,841	0.787
513	S Audobon	$108,534	$8,040	$7,621	0.948
1200	College	$146,482	$10,747	$7,031	0.654
1204	College	$80,951	$6,073	$6,282	1.034

The BCRs for the marginal structures are highly dependent upon construction costs. In this study, factors such as site condition, the need for dewatering, site access, etc. are unknown, thus the assessment of these marginal structures is estimated based on average conditions.

RECOMMENDED PLAN

This section evaluates the NED results for each plan developed separately in relation to the no-action plan. It draws on the results obtained for the benefit categories and costs developed in other sections and appendices.

A traditional analysis was performed using annualized benefit and cost estimates, an assessment of environmental acceptability, and impacts to local residents and businesses. Therefore, these costs are sufficiently accurate to allow elimination of plans that are infeasible. Upon initial analyses by areas, only Area 2 was economical. The analyses used for the recommendation were based upon individual structures, and their BCRs.

PLAN DESCRIPTION

Seventeen structures in Areas 1,2, and 3 have a BCR greater than 1.0. Eight of the structures are subject to greater than two feet of flooding, thus require structure raising to 10-feet. 1204 College was optimized at a 5-foot raise to achieve a BCR greater than 1.0. Floodproofing is the feasible and economical technique for the remaining structures. Table 8 lists the structures that are economically feasible for flood protection.

TABLE 8: RECOMMENDED STRUCTURES FOR FLOOD PROTECTION

Address	Area	Modified Livable First Floor (sq. ft.)	100-yr Flood Depth	Type of Protection	Height of Protection or Height of Raising (ft)	Protection Unit Cost/ Sq.Ft.	Total Construction Cost	BCR
1208 College	2	3250	5.65	SR	10	$49.17	$159,787	5.15
403 N Demanade	1	2000	3.2	SR	10	$49.17	$98,330	2.78
523.1 Beverly	2	1329	5.15	SR	10	$49.17	$65,341	2.56
509.1 Beverly	2	625	3.35	SR	10	$49.17	$30,728	2.33
400 N Demanade	1	3330	1.7	FP	3	$12.00	$39,960	1.74
503 S Audobon	1	3887	1.8	FP	3	$12.00	$46,644	1.73
209 Keller	1	2750	1.5	FP	3	$12.00	$33,000	1.68
113 Keller	1	3401	1.9	FP	3	$12.00	$40,812	1.37
512 E Demanade	1	2875	2.4	SR	10	$49.17	$141,350	1.30
505 S Audobon	1	3635	1.4	FP	3	$12.00	$43,620	1.29
217 Beverly	2	1708	0.75	FP	3	$12.00	$20,496	1.28
412 E Demanade	1	1652	3.1	SR	10	$49.17	$81,221	1.25
414 E Demanade	1	2051	3.3	SR	10	$49.17	$100,838	1.17
416 E Demanade	1	2822	3.2	SR	10	$49.17	$138,744	1.06
401 N Demanade	1	2200	1.3	FP	3	$12.00	$26,400	1.05
1204 College	2	1890	3.25	SR	5	$42.83	$80,951	1.03
417 E Demanade	1	2080	1.4	FP	3	$12.00	$24,960	1.02

PLAN APPROACH

Individual structural recommendations, which include structure raising and floodproofing, require coordination between contractors, the USACE and homeowners. Several different approaches to the coordination have been used by the USACE. One approach utilized and recommended by the Huntingon District to negotiate flood protection programs was to use a real estate instrument. The real estate instrument is based upon the following steps:

- USACE performs government cost estimate
- Homeowner selects contractor
- Homeowner provides name of contractor with their "proposal" to the USACE
- USACE compares the contractor costs to the government costs
- USACE executes an agreement with the homeowner
- The contractor performs the work
- USACE performs inspection
- Checks are paid when the job is complete

One major benefit of using the real estate instrument is that the contractor is not under agreement with the government, thus they do not have to go through the formal governmental process. The real estate instrument requires a great deal of up front work by the USACE (Barr, 2000).

REAL ESTATE REQUIREMENTS

Homeowners will provide all land for the non-structural flood protection measures proposed. There are no real estate requirements.

RELOCATIONS

No relocations would be required.

MITIGATION

The construction would avoid impacts to wooded habitat as much as practicable. Provided the landowner approves, the disturbed floodside habitat along the northern border would be replanted with native trees and shrubs, and with mixtures of native grass and wildflower species. No impact were identified that would require compensatory mitigation. All disposal sites will be in non-wetland areas.

OPERATION AND MAINTENANCE

Maintenance is required for the dry floodproofing and structure raising activities. Back flow valves should be checked annually at a cost of approximately $100 per home. In addition, every five years, sealants should be touched up and all shields checked. This would cost approximately $1000 per home (Taylor, 1999). Thus, this study incorporated an annual maintenance cost of $300 per home in the average annual cost per structure.

ENGINEERING AND DESIGN (E&D)

Engineering and Design (E&D) for this project consists of design plates for construction. Pending approval of this Detailed Project Report, additional funding will be provided to develop plans and specifications. E&D is estimated to be 5 percent.

SUPERVISION AND ADMINISTRATION (S&A)

Supervision and Administration (S&A) of construction contracts for this project is the responsibility of the New Orleans District. S&A is estimated to be 5 percent.

PLAN IMPLEMENTATION

INTRODUCTION

The purpose of this section is to present information concerning the Federal and non-Federal responsibilities regarding cost apportionment and the division of responsibilities for construction and subsequent operation, maintenance, and rehabilitation of the project. Such costs apportionment is based on Federal guidelines.

DIVISION OF PLAN RESPONSIBILITIES

FEDERAL RESPONSIBLITIES

The Federal government will be responsible for planning, engineering, design, and construction of the project in accordance with the applicable provision of Public Law 99-662 (WRDA of 1986). The Government, subject to the availability of funds and using those funds provided by the Non-Federal Sponsor, shall expeditiously construct the Project, applying those procedures usually applied to Federal projects, pursuant to Federal laws, regulations, and policies.

NON-FEDERAL RESPONSIBLITIES

In accordance with Federal policy, non-Federal interests must, at the appropriate time, assure the Secretary of the Army that they will, without cost to the United States:

A. Furnish all lands, easements, rights-of-way, and suitable borrow and dredged or excavated material disposal areas necessary for construction, operation, and maintenance of the Project, and shall perform or ensure performance of all relocations necessary for the construction, operation, and maintenance of the Project.

B. The Non-Federal Sponsor shall contribute a minimum of 35 percent, but not to exceed 50 percent, of total project costs in accordance with the Federal regulations.

C. The Non-Federal Sponsor shall provide a cash contribution equal to 5 percent of total project costs.

D. Hold and save the United States free from all damages arising from the construction, operation, maintenance, repair, replacement, and rehabilitation of the Project, except for damages due to the fault or negligence of the United States or its contractors.

E. Operate, maintain, repair, replace, and rehabilitate, as necessary, all features of the project, at no cost to the Government, in accordance with regulations prescribed by the Secretary of the Army, including levees, floodwalls, floodgates and approach channels, drainage structures, drainage ditches or canals, and all mitigation features.

F. Provide for the adjudication of all water right's claims resulting from construction, operation, maintenance, repair, replacement, and rehabilitation of the project, and hold and save the United States free from damages due to such claims.

G. Publicize flood plain information in the area concerned and provide this information to zoning and other regulatory agencies for their use in preventing unwise future development in the flood plain and in adopting such regulations as may be necessary to prevent unwise future development and to ensure compatibility with protection levels provided by the Project.

H. Within one year after the date of signing a project cooperation agreement, prepare a floodplain management plan designed to reduce the impact of future flood events in the project area. This plan shall be prepared in accordance with guidelines developed by the Government. The plan must be implemented no later than one year after completion of construction of the project.

I. Prescribe and enforce regulations to prevent obstruction of or encroachment on the project that would reduce the level of protection it affords or that would hinder operation and maintenance of the project.

J. Assure that construction, operation, maintenance, repair, replacement, and rehabilitation of any non-Federally constructed flood features do not diminish the flood protection provided by or jeopardize the structural integrity of the project.

K. Assure compliance with applicable Federal floodplain management and flood insurance programs.

L. The Non-Federal Sponsor may request the Government to accomplish betterments. Such requests shall be in writing and shall describe the betterments requested to be accomplished. If the Government elects to accomplish the requested betterments or any portion thereof, it shall so notify the Non-Federal Sponsor in a writing that sets forth any applicable terms and conditions. The Non-Federal Sponsor shall be solely responsible for all costs due to the requested betterments and shall pay all such costs.

M. Not less than once each year the Non-Federal Sponsor shall inform affected interests of the extent of protection afforded by the Project.

N. Comply with the applicable provisions of the Uniform Relocations and Real property Acquisition Policies Act of 1970 (PL 91-646), as amended by Title IV of the Surface Transportation and Uniform Relocations Assistance Act of 1987 (PL 100-17).

O. Comply with Section 221 of Public Law 91-661, Flood Control Act of 1970, approved December 31, 1970, which provides that the construction of any water resources project by the Corps of Engineers shall not be started until each non-federal interest has entered into a written agreement to furnish its required cooperation for the project.

P. Comply with Section 601 of Title IV of the Civil Rights Act of 1964 (PL 88-352) that no person shall be excluded from participation in, denied the benefits of, or subject to discrimination in connection with the project on the grounds of race, creed, or national origin.

VIEWS OF LOCAL SPONSOR

The local sponsor, the Louisiana Department of Transportation and Development (LaDOTD), is an active participant in the study process. The department is supportive of a Non-Structural solution to the flooding. Each homeowner is envisioned to serve as the local sponsor

during construction. Neither LaDOTD nor Lafayette Parish, at the time of this report, will elect to serve as a non-Federal sponsor on individual home improvements.

STATEMENT OF FINANCIAL CAPABILITY

Homeowners interested in participating in structure raising or flood proofing are required to contribute 35 percent of the costs for their individual structure. Homeowners will be responsible for 100 percent of the incremental costs of raising structures higher than that recommended in this report. Homeowners will also be responsible for 100 percent of the costs of modifications or improvements beyond that recommended in this report.

Homeowners will be required to provide proof of their ability to pay for their share of the costs prior to non-structural measures being implemented.

SUMMARY OF COORDINATION AND PUBLIC INVOLVEMENT

STUDY MANAGEMENT

The U.S. Army Corps of Engineers, New Orleans District, had the responsibility of conducting and coordinating the feasibility study, consolidating information from other agencies and interested parities, preparing the report, and formulating the alternative plans in conjunction with the non-Federal sponsor. During the course of this study, coordination was initiated and maintained with the Louisiana Department of Transportation and Development (LaDOTD), the Lafayette Consolidated Government and the U.S. Fish and Wildlife Service.

PUBLIC INVOLVEMENT

Two public meetings were held to obtain public comment on the flooding problems and potential solutions. One took place in August 1997 and the second in April 1998. The purpose of the first meeting was to discuss the study purpose and goals, introduce the study team; present non-structural measures used in other parts of the country, and solicit comments from the audience. The purpose of the second meeting was to discuss findings to date; present some options for non-structural measures in each area, and solicit preferences from the audience. Each meeting is described briefly below. (Many of the comments received at the public meetings concerned the structural flood control efforts, which are not a part of this study but are presented here nonetheless.)

As a result of the first public meeting it became apparent that it was necessary to show residents how their homes may look if structure raising were implemented. Additionally, the study team felt it was important to illustrate how floodwalls and small levees could be situated in their neighborhoods. Prior to viewing the computer visualizations shown below, many of the residents found it hard to picture how levees, concrete walls and raising homes would appear in their particular areas. The study team felt that this was an important hurdle to overcome in order to discuss the benefits and future direction of implementation. Prior to the start of the second public meeting, the town hall was filled with numerous computer visualizations of actual homes and channels in the respective areas. These visualizations worked very well and sparked the

positive interests of the residents. It led to a very successful discussion, which is presented below.

Home being investigated for raising

Computer visualization of proposed raising 8-feet

Existing channel

Proposed 5-foot concrete floodwall

CONCLUSIONS

Seventeen structures are recommended for either structure raising or dry flood proofing. Benefit to cost ratios were developed for several options including determining feasibility for structure raising and dry flood proofing for each individual home. The study team felt that it was necessary to establish a plan based upon benefit to cost ratios for each home, in lieu of a group of homes. This provides for flexibility in the case that one or more residents elect not to participate; the remaining homes would still constitute a feasible plan.

At this time, neither Lafayette Parish nor LaDOTD plan on serving as the local sponsor. Future conversations are planned with individual homeowners to determine their interest in participating as the local sponsor for improvements to their respective home(s). At the time of this report it appears that non-structural solutions may not be warranted in these three areas due

to comprehensive flood damage reduction solution in Lafayette Parish anticipated to significantly lower stages along the Vermilion River resulting in lower stages in these areas. The non-structural solution may be reexamined if residual damages exist once the comprehensive plan is authorized for construction. As a result of this effort, the study team found that is was very helpful to provide the residents with examples of non-structural aesthetics. Computer visualization is one suggested measure to achieve this goal and promote constructive conversation with residents in jeopardy of flooding the next time it rains.

CYPRESS CREEK
HARRIS COUNTY, TEXAS

PROBLEM DESCRIPTION

Cypress Creek is located on the Texas Coastal Plain, in northern Harris County that is part of the Houston Metropolitan Statistical Area. Cypress Creek is a tertiary tributary of the West Fork of the San Jacinto River and drains approximately 320 square miles of northern Harris County and eastern Waller County. It is formed by the junction of Snake Creek and Mound Creek in Waller County and flows easterly for a distance of 54 miles to its confluence with Spring Creek immediately north of the Houston Intercontinental Airport.

The dynamic growth of residential and commercial development in the watershed east of Highway 290 in Harris County increased runoff and intensified flood damages. Several tributaries have been improved, providing an even greater quantity of water for the mainstream to carry. Inadequate local drainage and the growth of brush and trees in the channel have aggravated flood problems. Also the sandy slopes of Cypress Creek have eroded into the channel, further reducing its carrying capacity. The study area begins just upstream of Highway 290 and continues downstream (east) to the confluence of Cypress Creek and Spring Creek.

The Texas Coastal Plain is flat producing floods characterized by slow rise, long duration, and low velocities. Flooding typically occurs over an extended time period, generally starting with long duration rainfall and street flooding. Because the streets in Houston are used for tertiary drainage, access becomes problematic during flood events. Homeowners, who typically commute to the Houston Central Business District or other business centers within Houston, experience difficulty returning to their homes in order to take precautions against flooding.

Much of the general aesthetic appeal of the study area stems from its wooded, relatively undeveloped character. The predominant land use within the study area is residential. The land use pattern is typically suburban. Many of the residential structures sit on large or multiple lots, which suggest a rural ambience. Some residential properties have horse barns or other mixed-use outbuildings on adjacent lots. All of the structures in the Cypress Creek flood plain were built before the implementation of flood plain regulations.

Relatively recent flood history is as follows: A chain of thunderstorms on October 25, 1984 caused severe flooding. Intercontinental Airport, near the mouth of Cypress Creek, recorded 9.2 inches of rain in 24 hours, 7.5 inches of which fell between 10 a.m. and 4 p.m. on October 25, 1984. A peak flow of about 7,920 cfs was recorded at the stream gage at I-45. This storm was estimated at a 7-year frequency. Several hundred homes along Cypress Creek were flooded, and approximately 500 persons were forced to seek emergency shelter. Dense thunderstorms moved across northern Harris and adjacent Counties beginning in the afternoon of May 17,1989. Heavy rains continued through the night and into the early morning of May 18th. A flow of 12,400 cfs was recorded at the USGS gage at I-45 at 1 p.m., May 18th. Cypress Creek at I-45 was 9 feet over its banks. This storm was estimated at a 24-year frequency. This was the largest discharge since 1949 (22,100 cfs). Approximately 542 structures were flooded. Total estimated flood damages to these homes was $10 million. Additional rainfall in June 1989, flooded over 220 structures. In October 1994, a flow of 10,700 cfs was recorded.

Over 96 percent of the structures located within the 500-year flood plain are residential. Most are built with "slab on grade" foundations with no basements. Harris County entered the National Flood Insurance Program in 1972 after which floor elevations were required to be built at or above the 100-year flood elevation. About 5,081 homes, apartment units, and commercial and industrial establishments with a total value of about $774 million are located within the 500-year flood plain. Flood damages from the occurrence of this event under 1990 conditions of development would exceed $104 million. Approximately 1,541 residential structures are located in the 100-year flood plain, and a single occurrence of a flood of this magnitude would result in damages of about $46 million under current conditions of development.

PLAN FORMULATION

The following specific planning objectives were considered during the planning process:

1. Reduce the flood hazard and damage to existing properties within the flood plain of the Cypress Creek study area to a level which would protect against possible loss of life and hazards to health and safety and is acceptable to the majority of the study area's population, thus, helping to constitute an acceptable plan for the non-Federal sponsor(s).

2. Contribute to the preservation and enhancement of fish and wildlife resources of the existing stream environments, including the preservation of wetlands in conjunction with a project in the study area and maximization of opportunities for aesthetic appreciation of the environmental attributes of the area.

3. Preserve, conserve, or enhance the environmental and cultural resources of the study area and mitigate for any adverse impacts to the existing natural environment and identified cultural resources caused by any economically feasible flood control plan.

4. Maintain existing open space areas and maximize public recreational opportunities within the study area.

The full range of nonstructural measures was evaluated for possible use in the Cypress Creek watershed. Of the various measures, elevating the structures and permanent evacuation or buyout were retained as being the most applicable for preventing or minimizing flood damages for the predominantly residential areas within the study area. Raising structures and buyout were investigated for the 50%, 20%, 12.5%, 10%, and 4% flood plains. These flood plains were surveyed to determine the number of structures that would be subjected to floods of the different frequencies. The 50% flood plain contained one damageable structure; the 20% flood plain contained 39 damageable structures; the 12.5% flood plain contained 77 damageable structures; the 10% flood plain contained 114 damageable structures; and the 4% flood plain contained 286 damageable structures. Data on each structure was acquired from the Harris County Appraisal District to determine property descriptions and assessed values.

ELEVATION (Raise to Target)

Under the structural raising option, the damageable structure would be raised to a target elevation. In Harris County, an ordinance requires that structures built or substantially improved (which would include elevating) within the 1% flood plain must have their first floor at an

elevation of 1.5 feet above the base (1%) flood elevation. This condition prevents implementation of a plan that does not comply with the County ordinance. Therefore, it was concluded that all structures had to be raised to this height. The cost estimate included real estate costs, cost of construction to raise the structures to the target elevation, and engineering and construction management costs.

The average unit price for raising the affected houses was developed using a spreadsheet and was based on the known square footage of each house and on information contained in a 1990 report published by the Galveston District entitled "Raising and Moving the Slab-on Grade House." A base unit price for raising the house the first two feet was developed. Then an incremental unit price was developed for raising the structure above the first two feet to the target elevation of 1.5 feet above the 1-% flood. Validity of this adjustable unit price was confirmed by consultation with a local contractor doing this type work. The average cost to raise each house was established and used as the unit cost in the M-CACES estimate.

Information pertaining to the houses, such as location, type of construction, type of foundation, number of stories, square footage, and existing foundation grade was taken from a database acquired from the Harris County Appraisal District. Most of the homes within the flood plain are built on concrete slabs and were constructed prior to Harris County participating in the National Flood Insurance Program (NFIP). Therefore, many homes are more than 30 years old and like all subdivisions, the structural conditions and general up-keep, vary widely. Roughly half of the homes are one and one-half story or two-story.

The amount of raising required for each house was determined using the foundation grade elevation provided in the database and the 1% flood level developed in the H&H report. The majority of the homes in the 20% flood plain would require raising of from 7 to 8 feet with a minimum of 5 feet and a maximum of 11 feet for one home. For those homes within the 20% and 10% flood plains, the average height to be raised would be 5 to 6 feet. Homes within the 10% to 4% zone would require raising 4 to 5 feet. Contingencies were assigned based on complexity and uncertainty of the various components involved in house-raising. Costs for lands and damages are based on recent gross appraisals done specifically for this project. Construction was assumed to be accomplished by local contractors working for the landowner. The estimates included temporary relocation assistance payments to qualified participants under the Uniform Relocations Assistance and Real Property Acquisition Act of 1970 (PL 91-646).

BUYOUTS

For evaluation purposes, a voluntary buyout plan and a mandatory buyout plan were investigated. The buyout alternatives were based on acquisition of all damageable properties within the flood plain being investigated. The cost of the alternatives included acquisition of the property (structure and lot) at fair market value; appropriate relocation expenses determined in accordance with provisions of PL 91-646, and demolition and removal of structures. The land could then be used for recreation purposes or allowed to return to its natural state to serve as habitat. However, no recreational plan was identified or proposed as part of this project. Ultimately, the local sponsor would own the property. This program is not applicable to vacant lots. Under the voluntary buyout plan, 100 percent participation was assumed for estimating purposes, but it was assumed that roads and utilities remain in place and continue to be maintained. Under a mandatory buyout plan, all improved properties would be purchased and

the public infrastructure (water, wastewater, electricity, gas, roadways, etc.) would be abandoned. Benefits could be taken for this loss in infrastructure inventory.

NONSTRUCTURAL PLAN COMPARISON

The raise-to-target alternatives were based on 100% voluntary participation; the alternative was economically feasible with only 10% participation. However, there could be no assurance that the raise-to-target plan could actually generate the level of benefits shown in the tables since there was no mechanism to force any property owner to agree to have their structure raised nor have all property owners participate. Additionally, this also assumed that every structure was structurally sound and it was technically feasible to be raised. The most cost effective implementable plan, which satisfied the planning objectives, was mandatory buyout. Since the benefits derived from the raise-to-target and the voluntary buyout plans could not be assured, the NED plan was the mandatory buyout.

ECONOMIC ANALYSIS

Nonstructural Solutions to Flooding. Buyout was evaluated for those residential structures damaged by floods with annual exceedance probabilities of 50, 20, 12.5, 10, and 4 percent. Nonresidential structures were excluded from analysis of nonstructural solutions since their uses were incompatible with relocation. Examples of commercial and public uses within these targeted areas are a horse farm, a cemetery, a greenhouse nursery, a fire station, a sewage treatment plant, and an arboretum.

Buyout. Residential structures were evaluated for buyout based on each structure's damage potential by frequent flood events. This nonstructural solution entails the taking and demolition of structures with compensation to owners and residents for their property and relocation plus resettlement expenses. Benefits from permanent relocation can be classified into five categories: 1) the value for the new use of the vacated land; 2) reduction in damage to public property, such as roads and utilities; 3) reduction in emergency costs; 4) reduction in the administrative costs of disaster relief; and, 5) reduction in flood insurance subsidy.

This buyout analysis includes only the evaluation of a reduction in flood insurance subsidy and a reduction in post-disaster emergency costs. A change in land use is not anticipated since unimproved lots surround the targeted structures and by scattered development that conforms to FEMA flood plain regulations and County building codes. The implementation of this project would not produce contiguous parcels of land of sufficient size to suggest an alternative land use.

Reduction in Flood Insurance Subsidy Calculation. The flood insurance subsidy is determined by deducting the policy holder's average annual insurance premium, annualized expected deductible and annualized expected uninsured losses from the average annual equivalent loss and the administrative costs of flood insurance. The insured loss assumes coverage of all physical costs including damage to the building structure, damage to contents, and clean-up of the structure and contents (National Economic Development Procedures Manual-Urban Flood Damage, IWR Report 88-R-2, March 1988).

Uncertainty in the calculation of the subsidy is reflected in the average annual equivalent damages and the annualized deductible. Premiums calculated are based on current rates charged

for properties within the 1- percent annual exceedance probability FEMA flood plain of Harris County, Texas. Average annual equivalent damages were calculated using HEC's 1997 NexGen, Provisional Version 1. Damages with uncertainty and other parameters previously mentioned were incorporated into an @RISK spreadsheet for an estimate of insurance subsidy losses with uncertainty. An example of the calculation for a structure in the 50 percent annual exceedance probability flood plain is presented in Table 1.

Conclusion. The comparison of the four buyout plans is presented in Table 2. As can be seen from the information presented, buyout of the 39 residential structures damaged by the 20 percent annual exceedance probability flood event produced the greatest net excess benefits and a positive BCR.

Uncertainty associated with the damages reduced is presented in Table 3 for all buyout plans analyzed. Uncertainty associated with the net excess benefits and the BCR for each plan is presented in Tables 4 and 5, respectively.

During the social impact assessment and public involvement activities, several homeowners asked to be included in the buyout plan. Some of these homes were located outside the 20 percent annual exceedance flood plain but within the 12.5 percent annual exceedance probability flood plain and adjacent to a targeted structure. One of these homes was deemed economically feasible for buyout, the calculation for which is shown in Table 6.

TABLE 1
Flood Insurance Subsidy Calculation
For Buyout of Structure Within the 50% Annual
Exceedance Probability Flood Plain

Average Structure Value	$45,000
Average Contents Value	$26,100
Policy Holder's Average Annual Costs	
Annual Premium/Unit	$ 488
Premium/Structure	$ 330
Premium/Contents	$ 158
Standard Deduction/Unit	$ 563
Uninsured Losses/Unit	$1,688
Agency Average Annual Costs	
Residential Average Annual Damages	$23,440
Average Annual Damages/Unit	$23,440
Admin Costs for Flood Insurance/Unit	$ 121
Agent's Fee (15% Premium)/Unit	$ 73
Total Agency Costs/Unit	$23,634
Policy Holder's Costs/Unit	$ 2,739
Average Annual Subsidy/Unit	$20,895

Note:
Annualized deductible based on distribution of deductible by occurrence
(min. = $500, max. = $1000, most likely = $750)
Annualized uninsured losses based on percentage of structure value = 5%
Average annual equivalent damages generated by NexGen, Prov. Version 1
(mean = $23,440, st. dev. = $9,020)

TABLE 2

Benefits, Costs, Benefit-to-Cost Ratios

Nonstructural Plans-Mandatory Buyout of Various Percent Annual Exceedance Probability

Flood Plains - Dollar Values in $1,000's

	Mandatory Buyout 20% Flood Plain	**Mandatory Buyout 12.5% Flood Plain**	**Mandatory Buyout 10% Flood Plain**	**Mandatory Buyout 4% Flood Plain**
PWE Benefits				
Inundation Reduction	$5,248	$ 8,684	$11,305	$18,104
Post Disaster Costs	$1,187	$ 1,708	$ 2,216	$ 3,361
PWE, Total Benefits	$6,435	$10,393	$13,521	$21,465
First Cost	$4,699	$ 9,315	$15,690	$42,153
BCR	1.4	1.1	0.9	0.5
Net Excess Benefits	$1,736	$ 1,077	($2,169)	($20,688)
BCR, Inundation Reduction				
Benefits Only	1.1	0.9	0.7	0.4
No. of Structures	39	77	114	286
PWE, Benefits per				
Individual Structure	$165	$135	$119	$75
AAEV, Benefits per				
Individual Structure	$12	$10	$9	$6
AAEV Benefits				
Inundation Reduction	$386	$639	$832	$1,333
Post Disaster Costs	$87	$123	$163	$247
AAEV Total Benefits	$474	$765	$995	$1,580

Notes:
Dollar values in $1,000's
AAEV: Average Annual Equivalent Value
PWE: Present Worth Equivalent
10/97 Price Levels, 50 Year Project Life
Amortization Factor 0.073607
Discount Rate 0.07125

TABLE 3

Uncertainty associated with Average Annual Equivalent (AAE) Damages Reduced
Mandatory Buyout Plans
Dollar Values in $1,000"s

Residential Structures within each Annual Exceedance Probability Flood Plain	Existing Damages AAEV Mean	Existing Damages AAEV St. Dev.	Mandatory Buyout Residual Damages AAEV Mean	Mandatory Buyout Residual Damages AAEV St. Dev.	Mandatory Buyout Damages Reduced AAEV Mean	Mandatory Buyout Damages Reduced AAEV St. Dev.
20%	$545.1	$204.6	$71.4	$8.8	$473.7	$195.8
12.5%	$974.8	$359.1	$209.9	$104.6	$765.0	$254.5
10%	$1,379.9	$533.9	$384.6	$236.6	$995.2	$297.3
4%	$2,278.3	$946.1	$698.3	$412.5	$1,579.9	$533.6

Residential Structures within each Annual Exceedance Probability Flood Plain	Probability Damages Reduced Exceed Indicated Amount				
	95%	75%	50%	25%	5%
20%	$151.6	$341.6	$473.7	$605.7	$795.8
12.5%	$346.3	$593.3	$765.0	$936.6	$1,183.6
10%	$506.2	$794.7	%995.2	$1,195.7	$1,484.3
4%	$702.2	$1,220.1	$1,579.9	$1,939.8	$2,457.7

TABLE 4
Uncertainty Associated with Net Excess Benefits
Nonstructural Plans
Dollar Values in $1,000's

Mandatory Buyout within Annual Exceedance Probability Flood Plain	AAE Benefits		AAE Costs	Net Excess Benefits	
	Mean	St. Dev.	Constant	Mean	St. Dev.
20%	$473.7	$195.8	$346	$127.8	$195.8
12.5%	$765.0	$254.5	$686	$79.3	$254.5
10%	$995.2	$297.3	$1,155	($159.6)	$297.3
4%	$1,579.9	$533.6	$3,103	($1,522.8)	$533.6
Mandatory Buyout within Annual Exceedance Probability Flood Plain	Probability Net Benefits Exceed Indicated Amount				
	95%	75%	50%	25%	5%
20%	($194.3)	($4.3)	$127.8	$259.8	$449.9
12.5%	($339.4)	($92.3)	$79.3	$250.9	$497.9
10%	($648.7)	($360.1)	($ 159.6)	$40.9	$329.4
4%	($2,400.6)	($1,882.6)	($1,522.8)	($1,162.9)	($645.0)

TABLE 5
Uncertainty Associated with the Benefit to Cost Ratio (BCR)
Mandatory Buyout Plans

Mandatory Buyout within Annual Exceedance Probability Flood Plain	Expected BCR	Percent Probability BCR > 1	Probability BCR Exceeds Indicated Amount				
			95%	75%	50%	25%	5%
20%	1.4	74.3%	0.4	1.0	1.4	1.8	2.3
12.5%	1.1	62.2%	0.5	0.9	1.1	1.4	1.7
10%	0.9	29.6%	0.4	0.7	0.9	1.0	1.3
4%	0.5	0.3%	0.2	0.4	0.5	0.6	0.8

TABLE 6
Cost-Benefit Calculation
For Voluntary Buyout of Structure--15B300

Structure Value	$125,000
Contents Value	$72,500
Average Annual Equivalent Damages Reduced	
Inundation Reduction	$9,635
Emergency Costs Reduced	$1,010
Total	$10,645
Average Annual Equivalent Cost	$10,581
Benefit-to Cost Ratio	1.0
Amortization rate @7.125% =	0.073607

NATIONAL ECONOMIC DEVELOPMENT PLAN

The most cost effective, implementable plan, which satisfied the identified planning objectives, was mandatory buyout of the 39 damageable structures located within the 20% flood plain. Since the benefits derived from the raise-to-target and the voluntary buyout plans cannot be assured, the National Economic Plan (NED) was the mandatory buyout of the 20% flood plain and a benefit-cost ratio of 1.4. Recreation facilities were not proposed as part of the NED Plan, however, land would be available for potential future recreational development. The NED Plan did not require fish and wildlife mitigation.

PLAN IMPLEMENTATION

When the project would be implemented, all homeowners would be notified, a series of workshops, public meetings, local briefings and one-on-one discussions would be conducted to explain the requirements of the program, and homeowners would have been given information on the program. As participants made application to the program, the Corps would confirm the applicant's eligibility.

Buyout of the damageable structures in the flood plain involves three measures; acquisition of the structure and property, relocation of occupants, and demolition and removal of structures. The local sponsor would be responsible for the acquisition of all required real estate as well as relocation assistance payments for residents under the applicable provisions of the Uniform Relocation Assistance and Real Property Acquisitions Act of 1970, PL-646, as amended. The fair market value of the structure and property would be determined and negotiated with the property owner. The local sponsor would be required to obtain fee simple title, subject to existing easements, excluding minerals over all tracts to be purchased.

Acquired property would be evacuated. All structures would be demolished and debris removed and disposed of. Any excavated foundations would be backfilled. The evacuated area would be reseeded. A Preliminary Assessment Screening for hazardous and toxic waste would be accomplished for each tract prior to being acquired. Any lead-based paint or asbestos at structures would be properly disposed of.

In February of 1998, based on a congressional inquiry on the policy for PED costs, it was determined by the Chief of Engineers that PED costs expended prior to and during a reevaluation study should not be included in the economic justification of a proposed project. This policy decision was determined to be consistent with a broader economic analysis policy to include only the remaining costs and remaining benefits that would be expected to occur after a decision is made to continue development of a proposed project. The interpretation does not relieve the non-Federal sponsor of the responsibility of sharing the reevaluation study cost. Federal reimbursement will be required to achieve a 75/25 percent apportionment. The maximum net excess benefits are achieved by the 20% buyout alternative.

The structure to be acquired in the Federally supported buyout plan were primarily situated in two main areas or subdivisions, Grantwood and Lake Cypress Estates. The Corps of Engineers and the Harris County Flood Control District chose to have neighborhood workshop meetings with each of these neighborhoods to gauge public sentiment toward the idea of buying homes. On May 13 and 14, 1998, meetings with the subdivisions were held. At the workshops, project presentations were made, comments were received, previously mailed survey forms were returned, and questions were answered. The initial meetings and follow-on discussions indicate a substantial number of the residents are interested in a buyout plan. The information gathered through the public involvement process has been used to from a recommendation by the HCFCD staff to pursue the Federal project. A letter of support has been received from the HCFCD.

Also, a socio-economic impact analysis was conducted to assess the sentiment of the individuals who qualified for Federal funding. One-on-one interviews were conducted in a semi-private setting to discuss questions as well as opportunities involved in buyout of their property and collect information for the sociological analysis. The project team was able to conduct 35 individual interviews; only 5 homeowners have gone on record in opposition to the Federal project.

Related to the Federally funded buyout project, the Flood Control District proposed the development of a neighborhood plan for the two affected subdivisions. The goal was to assess the properties to be purchased as part of the Federal project and identify a contiguous area or contiguous areas that the neighborhood could have as an asset like open green space and/or active recreation space. In some cases, completing a contiguous area could mean purchasing additional homes and vacant lots at local sponsor cost. The Flood Control District continues to coordinate with the Civic Associations to address issues like: what happens to the acquired properties, which maintains the property, what other uses are allowed on the property, etc.

SUMMARY AND CONCLUSIONS

The economic evaluation of the flood damage reduction measures is based on October 1997 price values, 50-year project life, 100% participation rate, and 7-1/8 percent discount rate. Uncertainties associated with and probabilities for the nonstructural alternatives were developed.

The project investment is the cost associated with buying the properties within the associated flood plains and their removal, relocation of residents, and field inspection. The construction period for implementation of the plan is estimated to be 2 years.

Based on the latest reevaluation analysis, excluding PED costs, the buyout of the 20% flood plain maximizes the net excess benefits and can be justified based on economic criteria for Federal participation.

Postlude

The Galveston District's GRR was approved by ASA (CW) on 27 September 1999 and CG funds were received in FY00 in the amount of $4,463,000. This mount exceeds the Federal share of the project. The local sponsor, the Harris County Flood Control District (HCHCD), desired to expedite the razing of targeted structures for buyout once they had been publicly identified. Past experience with the FEMA buyout program had revealed problems with homeowners' ambivalence about their future, vandalism of abandoned housing, liability issues, and high costs of police surveillance of abandoned structures. The HCFCD was convinced that quick action on their part was necessary once the homes had been targeted but they were reluctant to expend funds for demolition prior to the executed PCA for fear of losing Federal funding.

The HCFCD began acquiring property in June, 1999. The legal vehicle which ultimately allowed them to demolish the structures without forfeiting Federal funding was Section 215 Agreement which was signed by ASA(CW) on 5 January 2000. Demolition began the following month. The PCA for Cypress Creek was signed on 18 January 2001. The HCFCD is expected to completely finish the project by July 2001 and will submit a "bill for reimbursement" to the Galveston District. The Galveston District will audit and reimburse the Federal share to the local sponsor. This reimbursement will most probably occur in early FY02.

SPRING CREEK
EAST RIDGE TENNESSEE
NASHVILLE, DISTRICT

INTRODUCTION

The Spring Creek study area has a long history of flooding problems and today, high potential for flood damage remains. A major flood in February of 1990 caused approximately $9 million in damages (in 1990 dollars). Another significant, yet similar flood occurred in 1992. The 500-year flood plain contains over 600 structures; approximately 522 residential, 99 commercial and public structures and 12 apartments.

The Tennessee Valley Authority (TVA) conducted a series of flood damage reduction studies beginning in 1991 and determined that a system of levees along Spring Creek had economic potential for federal involvement. The TVA recommended the City of East Ridge proceed with implementation of this system of levees to reduce flood damages. However, in 1994 TVA ceased providing federal flood protection assistance, leaving East Ridge without a federal sponsor. The U. S. Army Corps of Engineers was directed to reevaluate the TVA studies by the Water Resources Development Act of 1996 (WRDA 1996; Public Law 104-303). This direction is found in Section 572 of WRDA 1996 as follows:

"The Secretary shall conduct a limited reevaluation of the flood management study for the East Ridge and Hamilton County area, Tennessee, undertaken by the Tennessee Valley Authority and may carry out the project at an estimated total cost of up to $25,000.000."

PROBLEM DESCRIPTION

East Ridge is south of Chattanooga and to the east of Missionary Ridge. Bounded by Chattanooga on the west, north and east, the city is also geographically confined by the Georgia state line to the south. East Ridge has a total area of 8.1 square miles, compared with 124 square miles in the City of Chattanooga and 539 square miles in Hamilton County. A 1996 population estimate of East Ridge, Chattanooga, and the Hamilton County was 21,789, 153,154, and 295,183, respectively.

Interstates 75 and 24 intersect at the northeast border of East Ridge. Elevations within the city range from a low of about 660 feet above mean sea level (msl) along the banks of West Chickamauga Creek to a high of about 1,000 feet msl along Missionary Ridge.

Spring Creek is approximately 6.4 miles long and flows north out of northwest Georgia through the City of East Ridge to its confluence with West Chickamauga Creek just east of I-75. West Chickamauga flows into South Chickamauga Creek about 0.9 miles downstream of the mouth of Spring Creek. South Chickamauga Creek joins the Tennessee River 13.2 miles downstream of the mouth of West Chickamauga Creek. The Spring Creek watershed has a drainage area of 21 square miles above I-75 and a drainage area of 14 square miles above Ringgold Road. Approximately 55% of the watershed has been developed, leaving the

remaining 45% (primarily in Georgia) in small urban woodlots or early successional fields. The Spring Creek flood plain within the study area has been extensively developed, primarily for residential use. Land use in the upper watershed is also largely residential.

The study limits encompass 1.8 miles of Spring Creek. The upstream limit is at stream mile 1.88 where Ringgold Road (or State Highway 41 and 76), the major east-west route through the center of East Ridge and the major commercial hub, crosses the creek. From this uppermost limit, the stream flows northerly through the study area where it has an average bank height of 8 feet and an average channel width of 30 feet. The only significant tributary to Spring Creek within the study reach, the "Marlboro Creek" drainage, enters at approximately mile 0.9. This waterway was relocated in the early 1970's to accommodate the K-Mart area development. Spring Creek passes under Spring Creek Road (built up to overpass Interstate 24 in the early 1960's) at mile 0.65. From this point to the I-75 Bridge at mile 0.07, the stream is slightly braided and travels through wetlands. Spring Creek's confluence with West Chickamauga Creek is immediately downstream of Interstate 75.

The 500-year flood plain is used in this study as a limit of data collection. This does not mean that larger (though less frequent) floods are not possible. Rather, it reflects the decision to build an analysis around the core element of damage potential in the study area which can then be expanded to represent all reasonable flooding potential in a cost-effective way. Therefore, the 500-year flood boundary defines the specifically studied structures but do not include all those with some flood damage potential. A table listing the number and types of structures located in the 500-year flood plain of Spring Creek within the study area is provided below.

Table 1
Structures in the Spring Creek Flood Plain

	NUMBER OF STRUCTURES IN THE FLOOD PLAIN	
TYPES OF STRUCTURES	100-YEAR	500-YEAR
Residential & Apartments	382	534
Commercial/Public	84	99
TOTAL	466	633

The Nashville District Corps of Engineers conducted a limited Phase 1 Environmental Site Assessment (ESA) of the Spring Creek study area in May 1997. The purpose of this investigation was to obtain and evaluate information about environmental contamination or the potential for environmental contamination, which could pose a liability to the federal government and the City of East Ridge as a result of property or right-of-way acquisition.

The Hazardous, Toxic, Radiological Waste (HTRW) investigation revealed 19 tracts in the general project area, which exhibit potential contamination. Various findings are 55-gallon drums, buried automobiles, underground storage tanks (USTs), oil and grease staining, and unauthorized or illegal dumping sites.

Floods on Spring Creek range between two extremes: headwater and backwater floods. Headwater floods in the study area have been a result of heavy rainfall in the upper portion of the watershed in Georgia; backwater floods are the results of high stages on South Chickamauga

Creek and/or West Chickamauga Creek, which affects the lower reaches of Spring Creek. The highest known headwater flood on Spring Creek occurred on December 29, 1942. The highest known backwater flood on the Tennessee River which affected Spring Creek occurred on March 11, 1867. Regulation of the Tennessee River by TVA dams since that time has had no effect on flooding along Spring Creek. Other large floods occurred on Spring Creek in 1990, 1973, 1957, 1951, 1949, 1948, and 1936. There is no stream gage on Spring Creek so specific flood stage data is not available.

The Spring Creek watershed is approximately 55 percent developed. Of the remaining area, approximately 12 percent consist of the Chickamauga and Chattanooga National Military Park and community designated floodway areas. This leaves 33 percent of the watershed that is currently in open-space use and subject to future development. If this undeveloped area were to develop as the rest of the watershed has done, flood levels could be expected to increase less than 1 foot over existing levels.

Future development in the South Chickamauga Creek or West Chickamauga Creek watersheds should not cause major increases in flood levels affecting East Ridge during the project life. With their relatively large undeveloped area, a large amount of development would have to take place in either watershed to begin affecting flood levels. The downstream area nearest East Ridge and Chattanooga appears to have the highest potential for development. However, development of this area would have less effect on flood levels than development in the midland or upper areas of the watershed, which typically contributes most to maximum flood discharges.

There are presently no indications that growth of sufficient extent to substantially increase flood levels would occur in the midland or upper watershed areas of South Chickamauga or West Chickamauga Creeks. Also, floods from large areas such as this are usually generated by longer-duration storms. Runoff produced by this type of storm is not affected as much by increases in developed areas as are the shorter-duration storms (thunderstorms) that tend to produce large floods on smaller watersheds such as Spring Creek.

PLAN FORMULATION

PLANNING OBJECTIVES

The specific objective for this study is to reevaluate the structural alternative, levees, which was recommended by TVA in terms of their hydrologic and hydraulic performance, geotechnical and structural integrity, and cost effectiveness. The City of East Ridge also requested that nonstructural floodproofing measures for residential and nonresidential structures within the 100-year flood plain be evaluated. Therefore, several combinations of structural and nonstructural components were formulated into specific alternative plans for evaluation. In addition, the city requested 100-year level-of-protection (LOP) as a study objective. It was also desired to identify a project with a total cost of $25 million or less in accordance with the limit set by Section 572 of WRDA 1996.

WITHOUT PROJECT CONDITION

The benchmark for measuring flood damage reduction benefits and project performance is the without project condition. This condition is established as the condition most likely to occur over the period of analysis (50 years) in the absence of a federal project.

As indicated earlier, little growth is expected over the next 50 years in the study area. The City of East Ridge has participated in the National Flood Insurance Program since 1972. Development within the floodway as designated by the Flood Insurance Study (FIS) is allowed only when it can be proven that this development will cause no increase in published 100-year flood heights. Otherwise, all new development in the flood plain is to be elevated to the 100-year frequency elevation plus 1-foot.

Expected annual damages to structures and vehicles for the without project condition are over $3 million. (See Table 2) They were calculated using the Nashville District's Direct Inundation Reduction Benefit (DIRB) computer program. This program integrates the project's structure file (containing finished floor elevations, values, locations, structural types), depth-damage relationships (for types of structures) and hydraulic profiles (depth of flooding along the stream at various flood frequencies).

As noted above, over half the potential damage occurs to the many residential structures in the flood plain. Approximately one-half of the potential average annual damages occur between stream mile 1.07 (just upstream of the Spring Creek Road bridge) to mile 1.34 (approximately halfway between Spring Creek Road and Ringgold Road).

Table 2
Existing Condition Damages by Structure Type

STRUCTURE/PROPERTY TYPE	EXPECTED ANNUAL DAMAGE	% OF ANNUAL DAMAGE
Residential/Apartments	$1,497,100	50%
Vehicles	240,700	9%
Commercial/Public	1,266,600	41%
TOTAL	$3,004,400	100%

FLOOD DAMAGE REDUCTION ALTERNATIVES

Flood reduction measures investigated in this reevaluation were limited to structural (levees) and nonstructural methods. Nonstructural methods investigated were limited to flood proofing, ring walls/levees, and raise-in-place. A flood warning and emergency evacuation plan was also considered. Table 3 provides a list of components which can be considered separately (to provide partial protection) or in combination (to provide partial or complete 100-year LOP). A description of each component is provided in the following paragraphs.

Levee A. Levee A providing right bank protection east and south of Spring Creek, as generally as proposed by TVA. Slight alignment changes, adjustments in levee heights, and refinements to interior drainage and outlet works were made, with the addition of a closure structure at Spring

Creek Road. The Corps' proposal is a 1.95-mile long combination earthen levee and floodwall. The floodwall, located along I-75 south, is 0.64 miles long and is to be constructed on an earthen embankment along the interstate in order to accommodate TDOT's proposed widening of I-75. Most of this floodwall will be in the range of 2 to 3 feet and the maximum height is 6 feet such that a cantilever I-wall may be used. An 84-ft wide by 12-ft high roller gate closure structure is proposed for Spring Creek Road. The proposed levee is 6,943 feet long and has a maximum height of 29-ft and an average height of about 19-ft. The levee cross-section is 10-ft top width with 2.5-ft H: 1.0-ft Vside slopes. Below ground elevation, an earthen inspection trench 5-ft wide and 5-ft deep would run along the centerline of the levee.

Levee A requires two interior drainage ponding areas. The main ponding area, A-Main (approximately 14.0 acres) requires a pump station (including three 13,500 GPM pumps). A gravity outlet with a flapgate will allow normal surface flow to pass through the levee and flow into the creek. A second interior drainage ponding area, A-Upper, (approximately 8.1 acres) would not require a pumping station but would require a gravity outlet.

Major (36-inch and 48-inch) sewer line relocations would be costly and may require an approximate 800-ft long section of floodwall instead of levee to allow space for both the relocated trunk lines and adjacent medical buildings. The levee construction requires acquisition and removal of 10 residential structures and 2 city-owned structures. About 11 acres of jurisdictional wetlands would be either directly or indirectly impacted by levee construction and would require sequential avoidance, impact minimization, and/or mitigation in accordance with the EPA/Corps of Engineers Memorandum of Agreement.

Table 3
Individual Components of Alternatives

TITLE	DESCRIPTION	STRUCTURES/ BUSINESSES PROTECTED
Levee A	Structural Protection of Most Eligible Right Bank Residential and Nonresidential Structures	185
Levee B	Structural Protection of Some Eligible Left Bank Residential and Nonresidential Structures	147
Residential Nonstructural	Nonstructural Protection of All Eligible Residential Structures in the Study Area	370
Nonresidential Nonstructural	Protects All Eligible Nonresidential Structures in the Study Area	86
Right Bank Nonstructural	Nonstructural Protection of All Eligible Residential and Nonresidential Structures on the Right Bank	174 Res.; 33 Nonres.
Left Bank Nonstructural	Nonstructural Protection of All Eligible Residential and Nonresidential Structures on the Left Bank	196Res.; 36 Nonres.
Marlboro Creek Residential Nonstructural Subset	Nonstructural Protection of Residential Structures along the Upper Marlboro Creek Drainage Area (all outside the levees)	45 Res.
Ringgold Rd Right Bank Nonstructural Subset	Nonstructural Protection of Residential Structures along Sewanee Dr & San Hsi Dr (near Ringgold) and Commercial Structures along Ringgold Road (all outside the levees)	12
Ringgold Rd Left Bank Nonstructural Subset	Nonstructural Protection of Commercial Structures along Ringgold Road between East End Ave and Spring Creek (all outside the levees)	7
K-Mart Area Nonstructural Subset	Nonstructural Protection of Left Bank commercial Structures along I-24 from K-Mart to Jernigans Furniture (all outside Levee B)	11
Flood Warning and Emergency Evacuation Plan	Provides a means of warning residents of an impending flood and evacuating people and property.	

Levee B. Levee B provides protection to the left bank property north and east of Spring Creek, as generally proposed by TVA. In their studies, TVA recognized the need for (but did not formulate) saddle dams in two low areas to keep flood waters from entering behind the levee. These areas are dense residential zones, so the Corps' saddle dam proposal is floodwall to

minimize construction impacts. Levee B is 6,095 feet (1.15) miles long with a 0.43-mile long north saddle dam floodwall extension of the levee and a 0.30-mile long south saddle dam west of Ringgold Road. The saddle dams would be concrete I-wall averaging 6-ft high. The residential roads traversed by each saddle dam would not be permanently closed. At the north saddle area, one would be ramped and two would require stoplog closure structures to be put in place when floods threaten. At the south saddle area, two would be ramped and two would require stoplog closure structures. An 84-ft wide by 8.5-ft high roller gate closure structure is proposed for Ringgold Road. The proposed levee would range up to 20-ft high, average 18-ft high, and have a 10-ft top width with 2.5-ft H: 1.0-ft V side slopes. A subsurface trench 5-ft by 5-ft would run along the centerline of the levee.

Levee B requires one interior drainage ponding area of approximately 13.2 acres and a pump station (including two 3,000 GPM pumps). A gravity outlet with a flapgate will allow normal surface flow to pass through the levee and flow into the creek.

Major sewer line relocations are required. Northwest of Levee B, Marlboro Creek would be relocated for a distance of about 1,300 feet. The levee construction requires acquisition and removal of 19 residential structures and 3 garages (includes saddle dam relocations). Only about 1 acre of jurisdictional wetlands would be impacted by Levee B construction and would require sequential avoidance, impact minimization, and or mitigation in accordance with the EPA/Corps of Engineers Memorandum of Agreement.

Residential Nonstructural. There are approximately 370 individual residential structures whose finished floor elevation (FFE) is at or below the 100-year flood elevation. The Corps' inspection of these homes concluded that the vast majority is on block foundations and is in sound structural condition. Typically, raising such structures in place is the least costly method of nonstructural flood proofing. The structures would be raised to a minimum elevation of 100-year plus 1 foot, East Ridge's flood plain requirement for all new construction

To evaluate the cost of raisings, the eligible residential structures were categorized into four basic structural types. A representative set of features for each category was input into a cost summary program, which quantifies house raising costs for each category. This average cost per category was multiplied by the total number of structures in each category for a total raise cost.

No attempt was made to perform a least cost analysis between flood proofing and flood plain evacuation. In most cases, flood proofing would be the least costly alternative. Development of a Flood Plain Masterplan would be necessary to determine the least cost alternative.

Nonresidential Nonstructural. Nonresidential structures whose first floor elevation are at or below the 100-year flood elevation include commercial structures, apartments, and public structures. There are five basic groups of nonresidential structures in the study area: 1). hotels, a retirement home, businesses and antique malls at the I-75/Ringgold Road exit along Mack Smith Road North; 2). the Fountainbleu Apartments, a gas station, and medical building along the east side of Spring Creek Road south of Spring Creek; 3). a hospital and clinics along the west side of Spring Creek Road south of Spring Creek; 4). the K-Mart shopping area between Interstate 24 and Spring Creek; and 5). various commercial structures along Ringgold Road at Spring Creek.

Experienced engineers who evaluated each of the 86 commercial and public structures in the 100-year flood plain in terms of least-costly protection methods conducted the nonresidential flood proofing analysis. Solutions considered included ring walls (I-wall, T-wall), ring levees, veneer walls (retrofitting), raising, and demolish/rebuild. The walls and levees were designed with pedestrian swing gate openings and vehicular stoplog closures for adequate access. The recommended alternatives consist of four group protections using ring walls/levees, numerous individual ring walls, and several raise-in-place options.

No attempt was made to perform a least cost analysis between nonstructural protection and flood plain evacuation. Typically, nonstructural measures are more cost effective than evacuation. In many cases, these structures are grouped and are amenable to protection using ring walls/levees. Development of a Flood plain Masterplan would be necessary to determine the least cost alternative.

Right Bank Nonstructural. The total residential and nonresidential nonstructural was divided into right bank and left bank subsets. Approximately 174 residential structures (47% of the 370 total in the 100-year flood plain) lie along the right bank of Spring Creek. Most of these structures are frame on block foundations and may be raised-in-place as the least costly alternative. Methodologies discussed previously would also apply for this subset of residential structures. In addition to the above residential structures, 33 nonresidential structures (48% of the 69 total in the 100-year flood plain) lie along the right bank of Spring Creek. Nonstructural flood protection for these structures includes raise-in -place, ring walls/levees, veneer walls, and demolish/rebuild.

Left Bank Nonstructural. The total residential and nonresidential nonstructural was divided into right bank and left bank subsets. Approximately 196 residential structures (53% of the 370 total in the 100-year flood plain) lie along the left bank of Spring Creek. Most of these structures are frame on block foundations and may be raised-in-place as the least costly alternative. Methodologies discussed previously would also apply for this subset of residential structures. In addition to the above residential structures, 36 nonresidential structures (52% of the 69 total in the 100-year flood plain) lie along the right bank of Spring Creek. Nonstructural flood protection for these structures includes raise-in-place, ring walls/levees, veneer walls, and demolish/rebuild.

Marlboro Creek Area Nonstructural Subset. Approximately 45 residential structures along the upper Marlboro Creek drainage (on the left bank of spring Creek) would not be protected by Levee B. Most of these structures may be raised-in-place as the least costly alternative. Methodologies discussed previously would also apply for this subset of residential structures.

Ringgold Road Right Bank Nonstructural Subset. In the Ringgold Road area, there are two commercial structures, a multi-use structure, a florist shop, and ten residential structures which would lie on the right bank outside the Levee A protected area. The residential structures could be raised-in-place and the commercial structures would require 3-foot and 6-foot floodwalls.

K-Mart Group Nonstructural Subset. Nonstructural protection of the five structures in the K-Mart commercial area representing approximately 10 commercial entities, was evaluated.

These structures lie on the left bank of Spring Creek, downstream of Levee B. It was determined that a ring wall/levee would be the least costly "nonstructural" alternative. Several of the northernmost structures, which would be encompassed by this ring wall/levee lie in the City of Chattanooga, outside the city limits of East Ridge. Also, the majority of benefits from this protection would be from the K-Mart structure.

Flood Warning and Emergency Evacuation Plan (FWEEP). This component would consist of developing a system of flood warning and evacuation. This would involve the installation of three gages to monitor rainfall and stream levels in the Spring Creek, West Chickamauga Creek, and South Chickamauga Creek basins and the development of a means of retrieving and utilizing this information to warn residents of an impending headwater or backwater flood. This plan would allow susceptible persons to evacuate the area and remove some of their property from the flood prone area; thus, reducing the threat to lives and property. Flood damages to structure contents and vehicles would be reduced but not eliminated at all levels of flooding.

ALTERNATIVES EVALUATED

No-Action Alternative. The No-Action Alternative was considered in compliance with ER-1105-2-100. Under this alternative no Federal action would be taken and the Spring Creek flood plain would continue to experience damaging floods, likely causing a decline in property value. The demand for developable land in East Ridge is considerable, however, and risky flood plain development may escalate due to these development pressures. In general, though, repeated flooding makes flood plain development economically unattractive.

Alternatives Providing Complete 100-Year LOP. Four alternative plans which provide complete 100-year LOP from flooding by Spring Creek for all structures within the study area were formulated (see Table 4). These alternatives, labeled Alternatives A, B, C, and D, consist of a combination of the structural and nonstructural components listed in Table 3. Alternative A consists of the levees and appurtenant nonstructural subsets. Alternative B consists of a levee and appurtenant nonstructural subsets on the right bank and nonstructural on the left bank. Alternative C consists of a levee and appurtenant nonstructural subsets on the left bank and nonstructural on the right bank. Alternative D consists of all nonstructural.

Other Alternatives. The components in Table 3 could be considered individually or there are numerous other alternatives comprised of one or more of the components, which could be used to provide partial, 100-year flood protection. For example, a Levee Alternative which includes Levees A and B but none of the nonstructural subsets required to provide complete 100-year level of protection was considered. This alternative would protect most of the residential and nonresidential structures on the right bank and some of the residential and nonresidential structures on the left bank from a 100-year flood on Spring Creek.

ENVIRONMENTAL ASSESSMENT

No Action. The No Action alternative offers no solution to existing problems. Repeated flooding makes flood plain development economically unattractive. A number of socioeconomic problems will continue unless some action is taken. These problems include: 1) recurring flood damage to personal property, utilities, roads, and other structures and the potential for loss of

life; 2) displacement of residents; 3) low property values and associated low tax revenues; and , 4) discouragement of capital investment. The reach of Spring Creek within the study area may be considered an economic liability rather than a community asset if nothing is done.

Levees. Alternatives containing Levee A and/or Levee B would not provide any greater level of protection (if freeboard is neglected) than alternatives comprised strictly of nonstructural components. Also, Levee A and/or Levee B would have a number of negative impacts on the environment which must be weighed against any economic gain. Levee A would affect about 11 acres of wetland. Levee B would affect less than 1 acre of wetland and would destroy about 13 acres of bottomland forest together with its associated wildlife populations. If either levee were to be constructed, appropriate mitigation measures would be required to offset the loss of habitat. Additional impacts such as the destruction of natural areas and annoyance factors along the haul routes would also be incurred from the development and use of borrow and spoil areas. The advantage of levees is that they provide a broad-based approach to flood damage reduction.

Residential Nonstructural. From an environmental standpoint, alternatives consisting entirely of nonstructural measures are preferred to as either No Action or structural alternatives. The raise-in-place measure proposed for residential nonstructural protection would have little or no adverse impact on wetlands and forest lands. In fact, for those few residences which may be evacuated rather than raised, the evacuated land would provide a benefit if converted to parks, playing fields, greenways, community garden spots, etc. No attempt has been made in this study to quantify these benefits. Raise-in-place would have few future operation or maintenance costs. Also, the voluntary nature of this alternative is a positive aspect for the residents involved.

Table 4
Plans Providing Complete (100-year) Protection

	Component Description										
Alternative Plans	Levee A	Levee B	Residential Nonstructural	Nonresidential Nonstructural	Right Bank Nonstructural	Left Bank Nonstructural	Marlboro Creek Area Nonstructural Subject	Ringgold Rd Right Bank Nonstructural Subset	Ringgold Rd Left Bank Nonstructural Subject	K-Mart Group Nonstructural Subset	FWEEP
A	x	x					x	x	x	x	x
B	x					x		x			x
C		x			x		x		x	x	x
D			x	x							x

Table 5
Economic Analysis of Alternatives
(Dollars - OCTOBER 1997)

Alternative	Construction Costs	Interest During Construction	Total Project Costs	Annual Costs	O&M Costs	Total Annual Costs	Existing Expected Damages	Annual Benefits	Residual Damages	Net Benefits	Benefit-to-Cost Ration
Alt A	$43,118,300	$4,946,190	$48,064,490	$3,537,888	$47,500	$3,585,388	$3,678,146	$3,561,225	$116,921	$ (24,162)	1.0
Alt B	$41,338,900	$2,564,297	#43,903,197	$3,231,587	$27,500	$3,259,087	$3,339,996	$2,027,225	$1,312,771	$ (1,231,862)	0.6
Alt C	$48,552,400	$2,381,893	$48,934,293	$3,601,911	$25,500	$3,627,411	$3,342,596	$2,508,332	$834,284	$ (1,119,079)	0.7
Alt D	$44,772,900	0	$44,772,900	$3,295,603	$10,500	$3,306,103	$3,678,146	$1,944,455	$1,733,891	$ (1,361,648)	0.6
Levee Alt (NED Plan)	$33,220,200	$4,946,190	$38,166,390	$2,809,317	$42,500	$2,851,817	$3,678,146	$3,034,513	$643,633	$182,896	1.1
Locally Preferred Plan	$22,664,400	/ 0	$22,664,400	$1,668,261	$5,500	$1,673,761	$1,540,400	$1,255,970	$284,430	$123,409	1.07

Table 6
RESPONSE TO PLAN FORMULATION CRITERIA

Formulation Criteria	Plan A	Plan B	Plan C	Plan D	Levee Alternative (NED Plan)	Locally Preferred Plan
Completeness	1	1	1	1	1	1
Effectiveness	1	1	1	1	2	2
Efficiency	2	3	3	3	1	3
Acceptability	2	2	2	2	2	1

Completeness

1. All necessary investment accounted for.

2. Other investments or Plans are cirtical to Realization of planned effects.

Effectiveness

1. Plan fully alleviates Specified problems and achieves specific opportunities.

2. Plane only marginally Addresses problems and opportunities.

3. Plan fails to adequately address any of the problems and opportunities

Efficiency

1. Plan is most cost effective means of alleviating the specific Problems and realizing the specified opportunities, consistent with protecting the Nation's environment.

2. Plane is marginally cost effective but still has positive BCR.

3. Plan is not cost effective

Acceptability

1. Plan is workable and viable with respect to acceptance by State and local entities and the public.

2. Plan is workable and viable, although no Preferred by local entities and the public.

3. Plan is totally unacceptable due to incompatibility with existing laws, regulational, and public policies

Nonresidential Nonstructural. Generally speaking, the proposed nonresidential nonstructural measures would have less operation and maintenance costs than a system of levees. Since I-wall is predominantly recommended, less footprint area would be impacted from these structures, minimizing or eliminating adverse impact to wetlands and forest lands. Nuisances associated with construction such as noise and dust would be inevitable, primarily due to the closeness of the I-wall to existing structures (approximately 4 feet). Raise-in-place impacts are minimal, as discussed above.

FWEEP. A flood warning and emergency evacuation plan would have no direct impact on environmental features, assuming that the associated rain and stream gaging equipment is installed in a responsible manner. Also, a FWEEP would address some of the socioeconomic problems experienced by the area. It would reduce flood damage to personal property and the potential for loss of life. It would enhance the value of currently flood-prone structures, increasing tax revenues. It may also encourage capital investment in the area. However, one socioeconomic problem the displacement of residents, may actually be exacerbated due to the potential for false alarms.

HAZARDOUS, TOXIC, AND RADIOLOGICAL WASTE (HTRW)

For the levees, further sampling and testing is recommended for 12 of the 19 tracts identified as having potential for HTRW contamination or groundwater contamination. Further interviews and site reconnaissance are needed at the other 7 sites. These sites are located along the levee footprint or are adjacent to lands potentially needed for the levees. For the residential nonstructural components only an asbestos assessment, which is outside the scope of this HTRW assessment, would need to be conducted. For the nonresidential nonstructural components (such as ring walls/levees), full Phase I investigations need to be conducted on all associated tracts. Further investigations for these structural-type solutions, beyond Phase II activities, may be required in order to estimate the extent of any contamination.

Social Effects. Social effects include the potential for the loss of life or health and community cohesion. The levees are proposed with 3 feet of freeboard and additional superiority height ranging from 1 to 3 feet. In theory, these levees could provide protection above the 100-year flood level (when considering freeboard as additional protection). Levee A would keep large residential and nonresidential areas intact; Levee B, with its two I-wall saddle dams, would tend to fragment some residential and nonresidential areas. Nonstructural house raising would keep neighborhood communities intact while lessening the potential for economic damage. Ring walls and levees would potentially have the highest possibility for catastrophic consequences since the freeboard height would potentially be less. In addition, they may be aesthetically unpleasant and may negatively impact businesses due to decreased visibility and accessibility.

NATIONAL ECONOMIC DEVELOPMENT

General. An economic evaluation of the alternative is made to evaluate their impact on National Economic Development (NED) and thus, to determine if an alternative has potential for federal interest. The alternative with the largest BCR is the one which maximizes net benefits and is typically identified as the NED plan.

Cost Estimating. The cost estimates were prepared in accordance with Corps of Engineers regulation ER 1110-2-1302 "Civil Works Cost Engineering". The cost account numbers are in accordance with the Work Breakdown Structure established in Micro Computer Aided Cost Estimating System (MCACES) Gold. Total costs are converted to average annual costs using an economic project life of 50 years at a current interest rate of 7-1/8%. The price level is October 1997. Alternatives were detailed enough to yield complete cost estimates for purposes of determining federal interest and to provide the City of East Ridge with reasonable estimated costs. Annual Operation, Maintenance, Repair. Rehabilitation, and Replacement (OMRR&R) costs for both major replacement and annual maintenance were included.

Levee Costs. Levee costs were complied by quantifying the major cost elements required from preliminary designs. These include land acquisition, construction, wetland mitigation, utility relocation, operation and maintenance, and appropriate contingencies.

Residential Nonstructural Costs. In past Corps experience, raising a house in place has been the least costly method of nonstructural flood proofing. The 370 one or two dwelling residences in the 100-year flood plain have relatively high structure and land values, therefore, further suggesting that evacuation or "buy-out" costs would be higher than raising costs. Therefore, only raise-in-place costs were quantified. The residential structures were categorized into one of the following: 1) siding with exterior heating, ventilation, air-conditioning (HVAC) units; 2) siding without exterior HVAC units; 3) Brick without exterior HVAC units. A representative set of features for each category was input into a cost summary program which quantifies house raising costs. A unit cost for each structure in a category was computed based on the average raise height for that category. Contingencies were set at 25%.

Nonresidential Nonstructural Costs. The cost of flood proofing the commercial, public and apartment buildings were quantified from the least-costly recommendation for each. Ring walls and levees, veneer walls (also called retro-fitting), and raising were considered. Lengths of walls were estimated, and costs were extracted form cost tables for various heights for each type of wall. Associated items such as closure structures and drainage works were extracted from similar district projects. Real estate costs were included along with a 30% contingency.

FWEEP Costs. The cost of a FWEEP was determined based on that of a similar system recently constructed in southeast Kentucky. It includes the cost of one Integrated Flood Warning System (IFLOWS) gages in each of the Spring Creek, West Chickamauga, and South Chickamauga Creek drainage basins to monitor rainfall and stream levels. It also includes the cost of developing and implementing a system to monitor these gages, identify an impending flood, and issue flood warning and evacuation notices. Operation and maintenance costs have been included.

Benefits. The benefits attributable to each alternative is calculated from the flood damages expected under both with and without project conditions. Benefits are the difference between existing damage and the residual damage with the alternative in place. This benefit may also be thought of as the "savings" borne by the particular alternative. The TVA calculates damages on susceptible property in a structure file originally complied from field data in the early 1990's. This structure file contains individual structure information such as structure number, type (residential/commercial/public/garage), type of construction, estimated value, and river mile from which flooding occurs. Corps personnel updated the structure values and stream miles (since Corps profiles use updated stream miles) and deleted several structures which no

longer exist. One moderately valued automobile per structure was assumed susceptible to flood damage. Using DIRB, the amount of flood damage expected on an annual basis from all frequency flood events was calculated. In addition, benefits from the reduction in flood insurance premiums and emergency costs due to nonstructural protection were determined. Benefits derived from a FWEEP were not determined as a part of this study.

Benefit-to-Cost Ratio. The average annual benefits and average annual costs are compared for each alternative in a BCR. This ratio must be greater than one (i.e. the benefits from the alternative must exceed the cost) in order for the alternative to demonstrate a federal interest.

Economic Data. Table 5 displays economic data for each alternative plan. An alternative must have a BCR ratio greater than unity in order to yield positive net benefits (the difference between the average annual benefits and average annual costs). Net benefits may also be thought of as the benefits which exceed the costs.

PLAN EVALUATION

Planning Objectives. The specific planning objectives were to reevaluate the TVA levees, formulate nonstructural measures, identify alternatives which provide a minimum 100-year level of protection, and identify a project within the WRDA 1996 cost limit of $25 million.

Response to Plan Formulation Criteria. Each of the alternative plans formulated in this reevaluation were evaluated based on how well they meet four plan formulation criteria, in accordance with ER 1105-2-100. An explanation of these criteria (completeness, effectiveness, efficiency, and acceptability) and the ranking of the plans considered are provided in Table 6. It was found that none of the alternatives which provide complete 100-year LOP (alternatives A, B, C, and D) have positive net benefits and, therefore, none of these plans fully meet the efficiency criteria. Additionally, none of the four plans was found to be acceptable to the local sponsor, nor did any of them meet the planning objective of total project cost less than the authorized limit of $25 million. Therefore, plans A, B, C, and D were eliminated from further consideration.

The National Economic Development Plan. The plan that reasonably maximizes net national economic development benefits and which is consistent with NEPA is called the National Economic Development Plan.

Plan A comes closest with $24,162 negative net benefits. The plan, which comes closest to meeting the study objectives while still having positive net benefits, is the Levee Alternative (a combination of Levees A and B). This alternative has $182,696 in average annual net benefits and a BCR of 1.1. Therefore, the Levee Alternative plan is identified as the NED plan. However, the cost of this plan, $33,220,200, greatly exceeds the authorized cost for this project.

The Locally Preferred Plan. Preliminary results from this study were presented to City of East Ridge officials in September 1997. They subsequently indicated that the Locally Preferred Plan is the Residential Nonstructural component. In several meetings and discussions after that time, they have reaffirmed their desire to pursue this alternative. Currently this plan has a net benefit of $123,409 and a BCR of 1.07. The cost of this plan, $22,664,400, is less than the authorized cost for this project.

THE LOCALLY PREFERRED PLAN

The NED plan is not preferred since it does not have the support of the local sponsor, primarily due to affordability. Additionally, this plan would require additional congressional authorization since its cost is in excess of the current $25 million authorization. The City of East Ridge has expressed a desire to implement the Locally Preferred Plan, Residential Nonstructural. This plan is more socially and environmentally acceptable than the NED plan. It also is more within the economic ability of the local sponsor to fund the local cost share. In the City's opinion, the Residential Nonstructural Plan provides the most protection possible within their economic cost-sharing ability.

Chapter 5 of ER1105-2-100 contains a provision that would allow the selection of a lower cost, Locally Preferred Plan in lieu of the NED plan if approved by the Assistant Secretary to the Army for Civil Works (ASA(CW)).

The need for a Flood Warning and Emergency Evacuation Plan (FWEEP) has been identified by the City of East Ridge. This is an integral component of non-structural flood reduction projects and, for very little cost, would serve to further reduce property damages and the threat to lives in the study area.

Description. The Locally Preferred Plan consists of the nonstructural protection of all 370 of the residential structures in Spring Creek's 100-year flood plain between Interstate 75 and Ringgold Road, as well as the preparation of a FWEEP. At this time, it is proposed that eligible structures (those within the 100-year flood plain) be raised in place to a height at least one foot above the 100-year flood elevation. During the development of a Flood Plain Masterplan, the cost to evacuate would be compared to the cost to flood proof.

Benefits. The Locally Preferred Plan would protect all 370 residential structures in Spring Creek's 100-year flood plain between Interstate 75 and Ringgold Road. A minimum of 100-year level of protection would be provided; additional protection may be provided depending on the final raise height since homes would be raised to the nearest block increment over one foot above the 100-year flood elevation. Average annual benefits of this plan are currently estimated at $1,255,970, but do not include the benefits that would accrue from a FWEEP.

Costs. It would cost an estimated $22,664,400 to implement the Locally Preferred Plan. The average annual cost would be $1,673,261.

PENTZ RUN
DUBOIS, PENNSYLVANIA

INTRODUCTION

Section 581 of the Water Resources Development Act of 1996 (WRDA 96) provided the authorization for this study. The authorizing language states, in part:

"The Secretary may design and construct flood control measures in the...Lower Allegheny, Lower Monongehela at a level of protection sufficient to prevent any future losses to these communities from flooding such as occurred in January 1996, but no less than a 100-year level of protection."

The Energy and Water Development Appropriations Bill of 1998 appropriated funds for flood control along Pentz Run in DuBois, Pennsylvania as identified in WRDA 96:

"The Committee has provided $3,000,000 for the West Virginia and Pennsylvania Flood Control project authorized in Section 581 of the Water Resources Development Act of 1996. Of the funds provided... $100,000 is for flood control on Pentz Run, DuBois, Pennsylvania."

The study purpose is to develop potential solutions for providing flood protection. The legislation does not require a benefit-cost ratio.

The study developed a Least Cost Plan for the City of DuBois that identified structural and/or non-structural measures to be carried into a detailed project report for further analysis. The study considered a variety of potential structural and non-structural methods for flood damage reduction, including the following:

Structural Measures	Non-Structural Measures
Levees/floodwalls	Flood plain evacuation
Channel modifications	Flood proofing
Impoundments	Flood warning systems
Diversions	Structure Raising

Pentz Run, contained within the City of DuBois and Sandy Township, is located in northwestern Clearfield County in west central Pennsylvania. DuBois is approximately 70 miles northeast of Pittsburgh. The population of DuBois is approximately 10,000.

This study concentrated primarily on the lower portion of Pentz Run located in the City of DuBois and Sandy Township.

PROBLEM DESCRIPTION

Pentz Run is a tributary to Sandy Lick Creek and is contained entirely within Sandy Township and the City of DuBois, Clearfield County, Pennsylvania. The upper reaches of Pentz Run are located in Sandy Township while the confluence of Pentz Run with Sandy Lick Creek is located within the City of DuBois. The rural nature of the area and small drainage area combine

to limit the flood damage problems in most of Sandy Township. The majority of flood damage along Pentz Run occurs between the area just south of the crossing of State Route (SP) 219 and the confluence with Sandy Lick Creek.

The Pentz Run watershed is approximately 4.8 square miles. Basin width varies from approximately 0.5 miles at the downstream end to approximately 2 miles at the upstream end. The watershed has a general north-south orientation. A well defined, 4 to 5 foot deep channel, varying through the project area from trapezoidal to rectangular in shape, characterizes Pentz Run through the identified flood damage area. Portions of the channel are lined with stone. The flood damage area is a wide flat area with a combination of residential and commercial structures. The majority of the flood damage area is within the City of DuBoise. The 100-year flood flow is 1,470 cubic feet per second (ft^3/s).

PLAN FORMULATION

In order to develop the Least cost Plan for this project, the level of protection that the project would provide was determined. Section 581 legislation states that the project should provide flood protection against the January 1996 flood elevation, but for no less than a 100-year level of protection. Based on discussions with local officials and residents, it was determined that for this project, the 100-year flood elevation is higher than the January 1996 flood elevation. Therefore, the 100-year flood elevation was used for design purposes.

The analysis used three elevations to define use of potential flood mitigation measures. These are the base flood elevation (BFE), the finished floor elevation (FFE), and the zero damage elevation (ZDE).

The BFE refers to the water surface elevation associated with the 100-year event at a specific location. The FFE is the elevation of the lowest livable/usable floor in the structure (including the basement if one was present). The ZDE refers to the elevation that damage to the structure can be assumed to occur[1].

A structure was considered to have a flood impact when the BFE exceeded the ZDE. For example, if the structure has a basement and the FFE equaled 100 feet, a flood impact would occur if the BFE exceeded 92 feet. This definition of flood impact results in the consideration of structures located outside the floodplain.

Flood Damage Estimation

The following provides the damage estimates for the Section 581 flood study along Pentz Run in DuBois, Pennsylvania. These estimates are related to computing existing flood damages in the City of DuBois and Sandy Township, as set forth in the Section 581 Legislation authorizing the Corps to design and construct flood measures along Pentz Run in these two communities.

Under guidelines set forth in the WRDA 96, the economic and other analyses are evaluated at the "expedited Reconnaissance level." This essentially involves utilizing existing data wherever possible, together with augmenting or collecting data where no information is available. The purpose of the "expedited Reconnaissance" is to speed up the planning process and move on to the Detailed Project Report, where a cost-sharing agreement would be signed by the Corps and a

non-Federal sponsor. For this study, new data were collected during site visits to the communities to gather information on damageability of structures. Residential and non-residential structure elevations were obtained by surveying first floor elevations, as well as estimating the zero damage elevation of a structure (the elevation where damages begin to accrue). The structure date was indexed to a river mile or distances displayed on the FEMA Flood Insurance Study (FIS) for a community. The dollar values of a structure and its contents were estimated by field observation and from data published in the Bureau of Census for 1990. All data are adjusted to 1998 values.

Available data analyzed included existing stage-damage-value relationships of structures, highways, and emergency costs. For residential structures, standard depth-damage-value relationships were used to determine the dollar value of damages to structures and their contents. Similar relationships available from previous studies were used for estimating depth-value-damage relationships for non-residential structures and contents (i.e., for supermarkets, restaurants, auto repair garages, convenience stores, banks, etc.). Likewise, hydraulic and hydrologic data were obtained from FIS reports for the City of DuBois and Sandy Township. Frequency-elevations were given for the 10-, 50-, 100-, and 500-year frequency floods. Using the above existing data shortened the time to complete the analysis, hence reducing the cost that normally would be incurred.

Flood damage estimates for each community were assessed by dividing the left and right banks of the stream. Distances along the stream were separated into smaller areas (reaches) to estimate damages by small areas and to delineate where a protective measure may be developed. Using field data, the flood damage program FLOODDAM, was used to determine stage-frequency-value relationships and generated flood damage frequency by structure, average annual damages by reach, and summarized damages for the community.

The study area was divided into 10 reaches. Table 1 provides a description of the reaches used to calculate damages and costs for the City of DuBois and Sandy Township.

TABLE 1
REACH DESCRIPTION

Reach	Stream	Stream Bank	Reach Description
L-1	Pentz Run	Left	Downstream of Long Avenue
L-2	Pentz Run	Left	Long Avenue to Weber Avenue
L-3	Pentz Run	Left	Weber Avenue to Spring Street
L-4	Pentz Run	Left	Spring Street to the City of DuBois Sandy Township boundary line
L-5	Pentz Run	Left	Upstream of the City of DuBois Sandy Township boundary line
L-6	Pentz Run	Left	Area between U.S. 219 and Pentz run in Sandy Township
R-1	Pentz Run	Right	Downstream of Long Avenue
R-2	Pentz Run	Right	Long Avenue to Weber Avenue
R-3	Pentz Run	Right	Weber Avenue to the City of DuBois – Sandy Township boundary line
R-4	Pentz Run	Right	South of City of DuBois-Sandy Township boundary line

Note: This study applies the convention that when facing downstream along a reach, the left bank is on the left side and the right bank is on the right.

For this study, data were collected for 307 structures, 75 non-residential and 232 residential. Of these, 62 non-residential and 179 residential structures are located within the 100-year FEMA floodplain boundaries. Upon evaluating the data, it was determined that 48 non-residential and 206 residential structures would be affected by the 100-year flood by comparing the ZDE and BFE elevations. The differences between structures in the floodplain and those structures affected by the 100-year flood may be a result of approximations in the floodplain boundary locations.

Most development upstream of Weber Street is on the left bank. Total flood damages associated with the 100-year flood event are estimated at $5 million; and average annual damages are estimated at $474,000. The 1990 census data indicated that the typical home is a 2-story frame dwelling with basement, 59 years old and valued at $41,500. Equimeter, Inc., the largest industry in the study area, manufactures industrial and commercial gas meters. Commercial establishments are diversified and include restaurants; automotive sales; service and supply; hardware store; laundromat; dry cleaning; engineering services; fire and ambulance services.

Structural and Non-Structural Measures and Costs

Determining the Least Cost Plan for flood protection necessitated reviewing a series of structural and non-structural measures in the City of DuBois/Sandy Township study area. This section describes the physical and cost methodology applied to review the alternatives and produce the Least Cost Plan.

To develop the Least Cost Plan alternative, the study considered flood protection measures for each flood reach. A series of physical and economic factors were applied for each structural and non-structural measure. These factors were based on existing literature and professional experience. For example, structural costs for floodwalls and levees were taken from "Engineering Principles and Practices of Retrofitting Flood Prone Residential Structures" (as were several other estimates of costs associated with structural and non-structural measures) (FEMA, 1995).

To compensate for the time between publication of literature estimates and current (1998) costs, the study converted costs to present values assuming a 3% annual inflation rate. This rate appears satisfactory considering that all of the literature applied was published between 1993 and 1998.

After developing the cost of a structural or non-structural alternative, the study added costs of 32½ % to account for professional services costs. As presented in Table 2, these professional services include planning, engineering, and design; cultural resources; environmental assessment; and construction management.

TABLE 2
PROFESSIONAL SERVICES COSTS

Professional Service	Added Cost
Planning, Engineering, and Design	21 ½ %
Cultural Resources	2%
Environmental Assessment	1 ½%
Construction Management	7 ½%

To compensate for uncertainty in the cost estimation procedure, the study applied a 25% contingency to the cost estimate. This contingency rate applied to each individual portion of the cost estimate, including professional services costs.

The study obtained estimates and appraisals of building characteristics in each reach. The characteristics included parameters such as FFE, structure type (i.e., single family, mobile home, one-story, two-story, commercial), structure material (i.e., wood frame, masonry, metal), and foundation type (i.e., slab, block, basement).

For this reconnaissance, structure specific information was not available. Some parameters such as structural dimensions, configuration, exact location, age, and integrity were estimated

based on observable quantities. For each flood protection measure, the study considered physical, policy, and engineering constraints associated with the measure.

Structural Measures

When determining the required structural measure (i.e., levee or floodwall) height for protecting the community from the design event floodwaters, the study used maximum whole number value for the affected reach area. For example, should the study area have three houses with the BFE exceeding the ZDE (height of protection) by 2.5, 2.1, and 2.7 feet, respectively, the minimum height of the structural measure would be 3.0 feet, plus any freeboard.

a. **Levees**

Levees were considered as viable options in areas where the footprint of the levee would result in minimum disruption of the study area. The study used the height of required protection, a 10-foot top width, and embankment side slopes of 3:1 (up to 2:1 on the face of the embankment, if space allowed) to determine the required footprint. The study applied a freeboard requirement of 3 feet, commensurate with typical engineering practice. The study did not consider levees with a total height (including freeboard) greater than 12 feet. Likewise, the smallest levee considered would be a total height of 3 feet (i.e., all freeboard).

Costs for levees were developed based on 1-foot height intervals ranging from 3 to 12 feet. Table 3 presents these costs[1]. Once associated with a height of protection, the cost was multiplied by the linear foot (lf) of protection to compute the total cost.

The levee costs include a typical foundation depth of 1-foot, seeding, and stabilization. The levee costs do not include ancillary costs such as land acquisitions, embankment protection, and some drainage. These costs would be in addition to the costs shown below.

TABLE 3
LEVEE COSTS

Height (ft)	Cost ($/lf)	Height (ft)	Cost ($/lf)
3	$56	4	$73
5	$100	6	$122
7	$139	8	$160
9	$180	10	$200
11	$222	12	$242

Source: FEMA. 1995

b. **Floodwalls**

Floodwalls were considered as viable options in areas where a limited footprint precluded the use of levees. For a floodwall, the study assumed a required footprint width for construction

[1] Additional costs for heights were based on a linear extrapolation of published costs.

and easements of 10 feet. The study applied a freeboard requirement of 2 feet, commensurate with typical Corps practice (FEMA suggests using a 1-foot freeboard value for floodwalls). The study did not consider floodwalls with a total height (including freeboard) greater than 12 feet. Costs for floodwalls were developed based on 1-foot height intervals ranging from 2 to 12 feet. Table 4 presents these costs. Once associated with a height of protection, the cost was multiplied by the linear foot of protection to produce the total floodwall cost. The floodwall costs do not include ancillary costs such as land acquisition, scour protection, and drainage.

TABLE 4
FLOODWALL COSTS

Height (ft)	Cost ($/lf)	Height (ft)	Cost ($/1f)
2	$89	3	$110
4	$131	5	$158
6	$185	7	$207
8	$231	9	$225
10	$279	11	$303
12	$327		

Source: FEMA, 1995

c. **Channel Improvements**

Channel improvements consist primarily of widening, deepening or clearing a channel to improve its hydraulic capacity.

d. **Impoundments**

Use of impoundments would collect stormwater flows behind dams or embankments routing to attenuate releases to levels that would protect the community. Because costs of dams are typically large, these alternatives were considered only if the magnitude of flows were sufficiently low enough to balance these costs.

e. **Diversions**

Diversions serve to move water out of its intended pathway to alternative channels. Use of diversions was considered if the topography and layout of the community allowed construction of such a measure.

Non-Structural Measures

Non-structural measures consist of a combination of damage reduction strategies suitable for each individual building. The selected strategy was based on a series of criteria, incorporating building use, building construction, the presence of a basement, and the BFE relative to the FFE and ZDE.

a. **Wet Flood Proofing**

Wet flood proofing was assumed a viable alternative for most structures. Wet floodproofing cost was estimated to be 20% of the structure value. When considering wet floodproofing, the study assumed that these structures have major utilities in the basement. Relocation of these utilities to a higher floor may not be feasible because of the small structure size. Should this occur, wet flood proofing may require building a small addition or waterproof wall.

Costs for wet flood proofing structures also include relocation benefits under Public Law (PL) 91-646. These costs equal $3,000 per structure, including administrative costs.

b. **Dry Flood Proofing**

Dry flood proofing "is not generally recommended for buildings with a crawl space or basement, because these types of structures are susceptible to underseepage, which can result in significant "uplift' or buoyancy forces and create serious design problems" (Corps, 1993). However, for the purpose of this study, it was assumed that the duration of flooding along Pentz Run would be short relative to the time it would take for groundwater to collect around a foundation to a depth that would cause damaging buoyancy forces. Similarly, it was assumed that hydrostatic forces caused by groundwater against a sealed basement wall could be effectively relieved over a short period by underground perimeter drainage.

To avoid excessive hydrostatic pressures, brick or concrete block walls are not flood proofed above a height of 3 feet, and dry flood proofing is not applied to wood frame exterior wall construction (Corps, 1993). Cost estimates for residential structures with basements, on field observations and tabulated building features, assumed that a typical structure consisted of a wood frame over a masonry foundation exposed 3 feet from ground level to the floor joists. Flood proofing of the wood frame was considered effective for providing freeboard only. For commercial structures, it was assumed that dry flood proofing is feasible above the first floor elevation, and that the first floor elevation was generally at ground level. (FEMA, 1986). Dry flood proofing costs were estimated as shown in Table 5.

Costs for dry flood proofing structures also include relocation benefits under PL 91-646. These costs equal $3,000 per structure, including administrative costs.

TABLE 5
DRY FLOOD PROOFING COSTS

Item	Costs	Units of Measure
Sprayed on cement (1/8 inch)	$3.30	Square foot of wall
Asphalt (2 coats below grade)	$1.10	Square foot of wall
Periphery drainage	$30.80	Linear foot of perimeter
Foundation excavation	$66.00	Linear foot of perimeter
Plumbing check valve	$660.00	Lump sum
Sump and pump installation	$1100.00	Lump sum

Source: FEMA, 1995; Except foundation excavation (escalated to 1998).

a. Elevation

This measure raises the structure above the floodwaters enough so that the structure FFE cannot be damaged by the design flood event. Raising the structure was considered a viable alternative for most structures. This scenario consisted of providing 1-foot of freeboard between the design-event BFE and FFE. No structure was raised greater than 12 feet, commensurate with typical Corps practice.

The cost of raising structures was estimated based on the construction material of each structure. The structure raising costs include extending the foundation and utilities, and miscellaneous items such as sidewalks and driveways. These costs do not include the placement of fill or a new concrete slab in the basement, as may be advisable under certain circumstances. The costs applied were based on 1-foot intervals beginning at a 2-foot elevation (including freeboard). The costs for raising structures of different construction are presented in Table 6.

TABLE 6
COSTS ASSOCIATED WITH RAISING STRUCTURE

Height Raised (ft)	Wood-Frame on Open Foundation	Wood-Frame on Solid Foundation	Brick or Masonry Building	Slab-on-Grade
2	$20.87	$15.07	$27.82	$25.80
3	$21.74	$15.94	$28.69	$26.37
4	$22.61	$16.81	$29.56	$27.24
5	$23.48	$17.68	$30.43	$28.11
6	$24.34	$18.55	$31.30	$28.98
7	$25.21	$19.42	$32.17	$29.85
8	$26.08	$20.29	$33.04	$30.72
9	$27.24	$21.45	$34.20	$31.88
10	$28.40	$22.61	$35.36	$33.04
11	$29.56	$23.77	$36.52	$34.20
12	$30.72	$24.92	$37.68	$35.36

Source: FEMA, 1995 (escalated to 1998 dollars)

Costs for raising structures also include relocation benefits under public law (PL) 91-646.

These costs equal $6,000 per structure, including administrative costs.

b. **Buyouts**

The purchase of property was considered an effective and feasible mitigation option for buildings whose estimated value was less than the costs for the other mitigation options or in cases in which other mitigation options were considered infeasible or undesirable.

Buyout cost is based on estimated structure value plus an estimated land cost. At this reconnaissance stage, parcel sizes are not available so a $2,500 land value was assumed. A separate cost of $3,500 was added for each structure to account for demolition, debris removal, and landfill costs (including handling hazardous materials).

Costs for buyouts also include relocation benefits under PL 91-646. These costs equal $6,000 per residential structure, including administrative costs. For commercial structures, these relocation benefits would equal $50,000, including administrative costs.

a. **Combination**

The study considered combinations of measures when these combinations provided an adequate level of protection at the least total cost. For example, a structure with an unfinished basement (except for a furnace) may be considered for a combination of raising and wet flood proofing if the BFE was above the FFE and ZDE. The wet flood proofing would protect the utilities, while elevation would protect the livable spaces.

The costs also included the relocation benefits under PL 91-646 associated with raising the structure ($6,000 per structure, including administrative costs).

b. **Flood Warning System**

In certain situations, the study considered a simple flood warning system as single stations as part of the overall flood control measure. These single stations (estimated to cost $10,000) provide communities with telemetric information that could be used for road closures and other emergency responses.

Ancillary Costs

For each measure, the study added additional costs to account for unit, material, or other associated construction items. Table 7 presents these costs. These ancillary costs also include consideration of temporary work area easements. These easement costs are based on an estimated 20-foot wide area of length affected by the alternative for each affected property.

TABLE 7
ANCILLARY COSTS

Item	Units	Cost
48" culvert with flapgates	Each	$2,900
Raise manholes	Each	$1,750
Interior Drainage	Lump Sum	$4,405
Closures	Square foot	$77
Riprap (2' x 4')	Cubic yard	$45
Sidewalk	Linear foot	$10
Asphalt Driveway	Square foot	$7
Concrete Driveway	Square yard	$19
Land Acquisition	acre	$20,000

Source: FEMA, 1995; unpublished data (escalated to 1998).

Selected Plan

Without a project that would alleviate flood damages, the area surrounding Pentz Run will continue to be flooded, adversely impacting the study area. Based on the information gathered and discussions with the local officials from the City of DuBois and Sandy Township, doing nothing to alleviate flood damages is not locally acceptable.

Several different flood mitigation approaches were considered in developing the Least Cost Plan. Alternatives considered included the following: elevating (raising) or floodproofing structures to avoid floodwaters; structure buyouts to clear floodplains; use of retention or detention ponds to lower flood elevations; and widening of the channel to provide additional conveyance for the flood flow.

The application of a line of protection (levees and floodwalls) along Pentz Run was considered. It was determined that the use of levees and floodwalls would not be feasible for this project for two reasons; the developed nature of the project area along both banks of Pentz Run; and, the existence of six bridges and one box culvert within the project area that spans Pentz Run.

The use of detention ponds (impoundments) in addition to non-structural measures was studied. By detaining floodwaters upstream of the project area, the BFE may be lowered in the project area and may result in a lower flood protection cost. Revised cost estimates for non-structural mitigation were computed on a basis of a 0.5-foot reduction in the BFE, corresponding approximately to flood levels for a 50-year flood, and a 1-foot reduction in BFE, corresponding approximately to flood levels for a 25-year flood. Approximately 5 acres (4 feet deep) of detention pond surface area would be required for the 0.5-foot reduction alternative and 10- acres

(4 feet deep) would be required for the 1.0 feet reduction alternative. In order to achieve BFE reduction on Pentz, large storage volumes would need to be detained upstream in either one large stormwater management facility or in a series of smaller facilities. Four potential detention pond sites were located in the field, totaling approximately 5.0 acres (4 feet deep) of surface area available.

The cost of the 0.5-foot reduction alternative would be approximately $10,000,000. The cost of the 1.0-foot reduction alternative would be approximately $19,400,000. However, due to a lack of potential detention pond sites, the 1.0-foot reduction alternative was considered to be infeasible. A negative feature of locating stormwater management dams upstream of developed areas is that structures may become vulnerable to dam breaches. If this approach is carried into the Feasibility Study, further determination of feasible detention pond sites and a danger reach analysis would need to be completed.

Widening the existing channel through the project area to accommodate the 100-year flood flow was also considered. Preliminary analysis showed that a 40-foot bottom trapezoidal channel with 1:1 side slopes would be required to convey the 100-year flood, running at a depth or approximately 6.5 feet. The existing channel is much smaller than the required channel (10-15 feet wide). In addition, Pentz run crosses under six bridges and one box culvert, all of which are incapable of spanning a 40-foot bottom trapezoidal channel. With the cost of replacing each structure (estimated at approximately $450,000 each) added to the cost of land acquisition and actual construction costs, this alternative would cost approximately $10,500,000. This alternative may be attractive to the local sponsors because of the improvements to the local infrastructure (new bridges). In addition, a significant portion of money would be used primarily for that infrastructure, instead of being used to buyout, raise and floodproof residential and nonresidential structures. This alternative may attract state funding from the PennDOT to aid in the construction costs of the bridges.

Use of a comprehensive flood warning system was considered. However, due to a relatively small drainage basin area (4.8 square miles), flooding would occur too quickly for a flood warning system to effective.

The use of an open area (Brownfield) downstream of the confluence with Heberling Run was briefly considered for a stormwater wetland, which would also serve as a water quality facility to treat the Acid Mine Drainage flowing from Heberling Run. The idea was discarded due to the minimal flood mitigation benefits that it would provide.

The preferred Least Cost Plan for this project is non-structural mitigation. For each structure vulnerable to damage from the 100-year flood, the feasibility and cost of wet flood proofing, dry flood proofing, elevation, and buyouts were considered. The least cost feasible approach was selected.

Selected Plan Cost Estimates

The Least Cost Plan will cost approximately $10.3 million. A Cost Estimate Summary is shown in Table 8, for both residential and nonresidential structures. Table 9 summarizes the overall mitigation costs on a unit basis.

TABLE 8
PROJECT COST ESTIMATES

Item	Quantity	Unit	Unit Price	Amount
Non-Residential				
Buyout/Relocation	4	Structure	-	$660,000
Structure Raising	2	Structure	-	$131,000
Dry Flood Proofing	42	Structure	-	$632,000
		Subtotal (Non-Residential)		**$1,423,000**
Residential				
Buyout/Relocation	4	Structure	-	$303,000
Structure Raising	101	Structure	-	$3,112,000
Dry Flood Proofing	101	Structure	-	$1,370,000
		Subtotal (residential)		**$4,785,000**
	Subtotal (residential and non-residential)			**$6,208,000**
Professional Services				
Planning, Engineering, and Design	--	--	21.5%	$1,335,000
Cultural Resources	--	--	2.0%	$124,000
Environmental Assessment	--	--	1.5%	$93,000
Construction Management	--	--	7.5%	$466,000
		Subtotal (Professional Services)		$2,018.000
		Contingency (25%)		$2,056,000
		GRAND TOTAL		**$10,282,000**

TABLE 9
MITIGATION COST ANALYSIS

Total Cost Project	$10,282,000
Number of Structures Protected	254
Value of Structures Protected	$23,989,000
Mitigation Cost per Structure	$40,480
Mitigation Cost per Dollar of Structure Value	$0.43

Potential Hazardous, Toxic, and Radiological Waste

Many structures are considered candidates for buyout, elevation, or flood proofing. Given the age of these structures, asbestos-containing materials may be present. Asbestos should be identified and abated prior to the implementation of flood proofing measures that may impact these materials. Structures subject to buyout and demolition should also be inspected.

Proposed Deviations

The Least Cost Plan is consistent with generally accepted practices and Corps policies with the following deviations. The first item is consistent with Corps' practice but deviates from FEMA requirements. The last deviation pertains to Corps policies.

This project applies the concept of using freeboard for non-structural projects to provide additional protection to structures in the project area. These values are not required by local or NFIP policies. However, these guidelines are typically included in Corps projects to ensure a reasonable level of safety in the project.

The project did not apply the customary Corps economic criterion of a Benefit to Cost ratio (BCR) of unity (or above) to determine whether the alternative meets accepted Federal Interest. For the project, the enabling legislation permits the Corps to proceed by considering the Least Cost Plan without regard to the BCR.

Treatment of Vacant Lands

The buyout of structures will result in vacant land within the 100-year floodplain, and within the 100-year floodway.

The City of DuBois addresses Floodplain Regulations in their zoning ordinance. Guidelines are outlined for development in both the 100-year floodway and the 100-year floodplain. The basis for the delineation of the Floodplain Districts is the June 1978 FIS prepared by FEMA. The study was updated in August 1981; however, the guidelines outlined in the 1978 FIS are still applicable even though the Floodplain District boundaries may have changed in the updated FIS.

The City of DuBois' guidelines for development in the Floodway District (FW) state that no

development shall be permitted except where any increase in flood elevations caused by such development be offset with accompanying improvements, which have been approved by all appropriate local and state authorities. There is also a list of permitted uses of a floodway area that include agricultural uses, public/private recreational areas, and accessory residential, industrial and commercial uses, such as yard areas, gardens, previous parking areas, loading areas, etc. Existing structures may remain or be replaced provided that they are not expanded or enlarged unless the effect of the proposed expansion or enlargement on flood heights is fully offset by accompanying improvements.

Guidelines for development in the Flood-Fringe District (FF), which encompasses all of the area in the 100-year floodplain outside of the 100-year floodway, is permitted provided it is in accordance with all regulations of the underlying district and is undertaken in strict compliance with the flood proofing and regulated provisions contained in all applicable City codes and ordinances.

Any proposed development of vacant lands created by this mitigation plan should be consistent with the City's zoning ordinance. Furthermore, FEMA criteria should be followed pertaining to new construction or reconstruction in the flood plan. Under FEMA policy structures experiencing damage greater than 50% of value cannot be rebuilt.

Ability to Pay Analysis

The Ability To Pay (ATP) analysis is used to determine the non-Federal sponsor's cost-share of a flood control project. The focus is determining the cost-share breakdown is based on the economic conditions of the state and county in which the project is located. The measure used to determine this is the Per capita Personal Income (PCPI) of the state and county versus the PCPI of the nation. Poor counties located in poor states have the greatest opportunity to receive a reduction in a non-Federal cost-share; conversely affluent counties would not receive any cost-share reduction.

Section 103 (m) of the Water Resources Development Act (WRDA) 1986 directed the Secretary of the Army to establish rules for qualifying sponsors of flood control and agricultural water supply projects to receive reductions in the non-Federal cost-share requirements. The current guidance for determining the ability to pay is Engineering Regulation (ER) 1165-2-121, Section 103(m) of PL 99-662, dated November 1, 1989. This ER established two tests for qualifying ability to pay reductions in the non-Federal cost-share. The two tests are the benefit test and the income test.

In the benefit test, the Benefit Cost Ratio (BCR) is divided by 4 to yield the Benefits Based Floor (BBF). If the BBF is greater than or equal to 35%, the sponsor could qualify for a partial or full reduction.

Flood plain development along Pentz Run incurred flood damages from several large recent floods, including the January 19, 1996 flood. The proposed flood protection project consists of flood proofing residential and commercial structures. Construction costs are estimated at approximately $10.3 million and the annual costs are approximately $791,000. Annual benefits from the project are estimated to be $441,000. The BCR is 0.56. From this the computed Benefit Based Floor was estimated at 14% (0.56/4). Since the BBF is less than 35%, the sponsor could possibly qualify for a partial reduction in the non-Federal share if it passes the second test.

The second test is the income test. This test determines whether a non-Federal sponsor is eligible to receive a reduced cost-share, less than 35%. This test utilizes local and state PCPI factors to determine eligibility. The eligibility factor (EF) reflects local or state PCPI income divided by the national average per PCPI, expressed as a whole percentage.

The formula to calculate is as follows:

EF = (a – b1 x state PCPI factor) – (b2 x area PCPI factor)

Where:

a = 15.86794

b1 = 0.06771

b2 = 0.13543 (note: b2 = b1 x 2)

An EF less than 0.0 indicates that the local area is not eligible for ability-to-pay reductions. An EF between 0.0 and 1.0 indicates the area is eligible for partial reduction in the cost-share less than 35%. An EF greater than 1.0 indicates the area is eligible for a full reduction in the cost-share. PCPI data from the Bureau of Census was collected for the period 1994 to 1996, the latest three years for which information is available. The data showed that the average PCPI for Clearfield County was $17,820, as compared to the State's average of $23,673, and the Nation's average of $23,327. The PCPI factors for Clearfield County and the State were 75.28 and 101.48, respectively. When these factors were applied to the above formula, it yielded an EF of less than 0.0 for Clearfield County. Consequently, the non-Federal sponsor for Pentz Run project does not qualify for a reduction in the non-Federal cost-share.

Real Estate

The real estate requirements for this project vary depending upon the type of non-structural measure that is recommended. The non-structural measures are:

1) acquire the residential or non-residential structure, relocate the residents or businesses, and raze the structure.

2) raise the structure so that the first habitable floor is 1-foot above the design flood elevation;

3) provide exterior flood protection measures to the structure.

The standard fee simple estate, as prescribed in Chapter 5 of ER 405-1-12, will be used for those structures that are to be acquired. Each landowner or business owner that elects to participate in this voluntary program and have their land and structure acquired will have to relocate outside of the floodplain. Each relocated landowner or business owner is entitled to relocation benefits under Title II of PL 91-646. The Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970, as amended. Residential landowners may receive additional benefits, up to $22,500, in relocation benefits. Business owners are also entitled to

re-establishment expense benefits as provided for in the law.

Structures eligible for flood proofing are those structures that can be flood proofed by raising in place, making alterations to the structure, or moving the structure to a higher elevation on contiguously owned land and for which the flood proofing alternative is the Least Cost Plan. Landowners who choose to participate in the program by having their structure(s) flood proofed will be required to sign a flood proofing agreement, which outlines the terms under which their structure will be protected. Additionally, the landowners of those flood proofed homes will, most likely, require temporary relocation benefits while the work is being done.

The structure detail sheets, explanation of benefits and refined costs and a discussion of the sponsor's capabilities will be included in the Real Estate Plan, which is part of the Feasibility Study.

Cost Sharing and Funding

Implementation of the proposed Least Cost Plan requires cost sharing of the subsequent planning, design, and construction stages between the Federal government and the localsponsors. It is also contingent on securing adequate funds from all stakeholders.

Under the Section 581 program, the following cost-sharing ratios are in effect.

- General Management Plan – 100% Federal (this study)
- Detailed Project Report – Part of Pre-construction Engineering and Design (PED)
- PED – 75% (Federal) – 25% (local) initially with an additional payment at the time of construction to make 65% (Federal) – 35% (local) retroactively
- Construction – 65% (Federal) – 35% (local)

For the Federal share, limited Federal funds have been authorized and appropriated for initiating Detailed Project Reports. Subsequent congressional action will be required to complete the Least Cost Plan.

For the local share, several sources have been preliminarily identified as possible ways to assist the local sponsors with their portions of cost sharing. These sources and contacts are provided below:

1. Pennsylvania Department of Environmental Protection (PADEP), Bureau of Flood Protection Projects.

PADEP can assist local communities by paying up to 50% of the local cost share for construction of a flood protection project.

2. Pennsylvania Department of Community and Economic Development (DCED)

There may be several grant and loan programs to which local communities can apply for financial assistance.

3. In the State of West Virginia, to overcome the difficulty of raising their local share of the project cost, many communities have created what they call a Community Improvement Assessment District (CIAD). The CIAD includes all structures that participate in the non-structural portion of the Section 202 Program (having the same intent as the Section 581 Program). Each structure is assessed a percentage of the costs to perform the flood proofing and the landowner is permitted to pay the assessment over time. The West Virginia Housing Development Fund fronts the money to the local sponsor for the project then recovers their money through the assessment process. The fund becomes self sufficient over time so that more projects can be funded through this mechanism. The Kentucky Housing Development Authority has also participated in this type of program.

4. The Flood Mitigation Assistance Program (FMAP) is a federally funded and state administered program that provides grants to Pennsylvania communities for flood hazard mitigation projects. To qualify as recipients of these grants, a community must produce an application detailing the mitigation project designed to control flooding.

Summary and Conclusions

The City of DuBois Flood Control Project was authorized as a result of legislation set forth by Section 581 of the Water Resources Development Act of 1996 (WRDA 96). The Energy and Water Development Appropriations Bill of 1998 appropriated $100,000 of funding for flood control along Pentz Run within the City of DuBois. A portion of Pentz Run in northern Sandy Township was added to the study due to persistent flooding problems and repetitive request to the Corps, prior to the Section 581 legislation, for aid in alleviating the flooding problem in the Township. The primary purpose of this report was to determine the least cost flood protection along Pentz Run for the 100-year flood or the January 1996 flood, whichever is greatest, in the City of DuBois and Sandy Township.

Pentz Run, contained entirely within the City of DuBois and Sandy Township, is located in northwestern Clearfield County in west central Pennsylvania. The Pentz Run drainage basin is approximately 4.8 square-miles in area and all drainage eventually flows into Sandy Lick Creek. This confluence is located within the City of DuBois.

Local flood protection can be accomplished by implementing the Least Cost Plan, which includes a combination of buyouts/relocation; structure raising; and dry flood proofing of structures. The cost of designing and constructing this Least Cost Plan will be approximately $10.3 million. Floodwalls, levees, detention, channel widening, and flood warning were considered in the evaluation. However, each of these alternatives were either determined to be more expensive or technically infeasible.

Cultural, resources within the project area include the DuBois Historic District. However, there are no known archeological sites or Threatened or Endangered Species within the project area. There are a number of HTRW sites within the project area.

Proposed deviations included with the Least Cost Plan are the concept of freeboard to provide additional protection for structures in the project area and the concept of designing for a Least Cost Plan without regard to the BCR.

The proposed Least Cost Plan for flood damage reduction meets the necessary Federal interest criteria, such as Federal regulations and policies.

TUG FORK BASIN
MCDOWELL COUNTY, WEST VIRGINIA

INTRODUCTION

The Tug Fork Basin was devastated in April 1977 by the flood of record for the basin, causing an estimated $698.7 million (October 1996 Price Level) in damages. As a direct result of the losses from this flood, the Energy and Water Development Appropriations Act of 1981 (Public Law 96-367) provided authorization for development of flood protection measures for McDowell County and several other Appalachian counties. Section 202 of that legislation directed the Secretary of the Army, acting through the Chief of Engineers, to design and construct, at full Federal expense, flood damage reduction measures.in those areas impacted by the flood. The legislation stated that the benefits attributable to the project objectives exceed the costs of the measures. No benefit cost analysis is therefore required.

The original legislation has been modified some to the extent that non-structural protection is to be provided to the level of the 1977 flood, or the 100-year flood, whichever is greater. In addition, non-Federal interests cost of nonstructural flood control measures shall be 25 percent of the cost of such measures. The non-Federal interests for any such measures shall be required to provide all lands, easements, right-of-way, dredged material disposal areas, and relocations necessary for the project, but shall not be required to contribute any amount in cash during construction of the project.

PROBLEM DESCRIPTION

The scope of the project reported upon herein is limited to the 988 residential and nonresidential structures located within the floodplain of the April 1977 flood in the McDowell County Project Area that received significant damage to habitable living space from the April 1977 flood, or a recurrence of a flood equal in magnitude. This also includes portions of Tug Fork tributaries in the study area and areas in the city of Welch that were inundated by either headwater or backwater flooding during the April 1977 flood. The study area begins on the Tug Fork at the McDowell - Mingo County line and extends upstream approximately 55 miles to Anawalt, WV and includes the following tributaries: 1) Panther Creek, 2) Dry Fork, 3) Bradshaw Creek, 4) Barrenshe Creek, 5) Little Slate Creek, and 6) Elkhom Creek. Of the 798 residential structures, 27% are manufactured homes. The 190 nonresidential structures include 122 commercial structures, 26 churches, 16 mixed-use structures, 20 local government owned structures, and six state owned structures. Six local government owned structures qualify for relocation. Eight school structures (3 facilities) will require relocation and four school structures (3 facilities) will receive floodwall protection.

In addition to the severe financial losses incurred due to the frequent flooding in the area, there is an adverse psychological effect on the population. The prospect of future flooding discourages proper maintenance and repair of structures. This in turn causes early deterioration of dwellings and business structures and accounts for a large number of flood plain structures not considered to be decent, safe and sanitary (DSS) and in need of rehabilitation. This project would 1) indirectly upgrade the housing stock of the area; 2) preserve the river corridor for recreation and fish and wildlife habitat by clearing riparian zones of existing development; and 3) increase

enforcement of the National Flood Insurance Program (NFIP) in the project area by making the public more aware of the program.

Repeated flooding over the years has devastated the project area. Homes and businesses have been completely destroyed, literally swept off their foundations and carried to ruins downstream. Many homes were never replaced while others were replaced with manufactured homes. This partially accounts for the relatively large number of manufactured homes found in the project area (roughly 27%). The potential for future flooding in the project area, as evidenced by the structure damage caused by the April 1977 flood, has discouraged any appreciable rebuilding in the project area. What development that has occurred since the April 1977 flood has been limited to the replacement of homes and businesses previously damaged as enforcement of the NFIP has been heightened. The geography of the area with its limited developable space greatly restricts the landowner choices for housing.

The project area is similar to other rural project areas in the Tug Fork Basin and is characterized by a linear development pattern along the Tug Fork River. Housing locations, roads, and rail lines follow the streams. Because of the narrowness of the valley bottoms, rail lines follow one side. Except for an occasional logging road, strip mine road, or jeep trail, only a few paved roads emerge from the narrow valleys crossing a divide from the headwaters of one stream to, the headwaters of an adjacent basin. Industrial and housing developments are restricted by the rugged topography of the region and the potential for damages caused by floods.

The population of McDowell County was 50,659 in 1970. A decrease of 1.5 percent brought the population to 49,899 in 1980. The 1990 census determined that McDowell County's total population was approximately 35,233. This represents a decrease of nearly 29.4% from 1980.

One of the overriding problems in the Tug Fork Valley is the lack of decent, safe, and sanitary (DSS) housing to accommodate the existing and future needs. Repeated flooding has been the major factor causing accelerated attrition in the quality and quantity of housing and public infrastructure. Costs associated with chronic flooding have resulted in the neglect of homes and businesses. Further, the prospect of future floods tends to discourage proper maintenance and repair of structures. Many of the existing structures in the valley are in a dilapidated or deteriorating condition and in serious need of replacement or rehabilitation. Ability to move from the flood-prone areas is rigidly constrained by very rugged topography and the fact that much of the land is owned by large corporations that cannot or will not dispose of their holdings. These factors make moving from the floodplain prohibitively expensive for most residents.

Other obstacles also hamper the supply of DSS housing in the valley. The rough topography has helped constrain the construction of good transportation routes for the movement of materials and prefabricated homes into the valley. Also, there is the absence of a housing construction industry and a lack of affordable financing for home purchases. The valley's boom-and-bust economy has not made high volume home construction a desirable alternative to builders. Few local area builders have the financial resources--in terms of working capital or credit availability-necessary for large-scale speculative development. Mortgage money is extremely difficult to obtain, and the financing terms are restrictive. Commercial banks are hesitant to approve, and residents are reluctant to assume, the high monthly mortgage payments because of variable incomes (boom and bust cycles) associated with coal mining.

PLAN FORMULATION

Based upon the identified problems and opportunities within the study area, local desires, and the intent of the aforementioned authorization, the planning objectives of this study have been identified as follows:

- develop the most cost-effective, implementable plan to provide the, mandated flood protection for the McDowell County Project Area, which complies with Section 202 of Public Law 96-367 and all other applicable laws and regulations; reduce to the extent possible financial and personal losses;

- maintain to the extent possible the social and cultural resources of the McDowell County Project Area;

- minimize to the extent possible the social and economic disruptions within the McDowell County Project Area; and

- develop the most socially acceptable and environmentally sound plan for the McDowell County Project Area.

NONSTRUCTURAL SOLUTIONS

General. Given the array of structural alternatives evaluated and costed, it was concluded that protection of the project area by means of structural alternatives would be cost prohibitive or otherwise infeasible. Additionally, since other projects in Kentucky and West Virginia have already been constructed or are under construction, the benefits associated with these structural measures would be further reduced. It was decided that efforts should be concentrated upon the development of voluntary nonstructural measures to provide flood protection to the project area. Generally these measures include flood proofing and floodplain evacuation, construction of Housing and Community Development (H&CD) sites, flood insurance/floodplain zoning, flood warning and emergency evacuation plan, and financial compensation. These alternatives are discussed in detail in the following paragraphs:

Flood Proofing and Flood Plain Evacuation. Nonstructural alternatives such as flood proofing and flood plain evacuation have proven to be very effective flood damage reduction measures in areas such as this project area where scattered and linear flood prone development prevails over extensive reaches of the flood plain. Application of these measures in an area such as this project area enables location-specific flooding problems to be addressed directly without incurring the problems and costs associated with providing equitable protection to adjacent structures or clusters of structures. The acceptability of these measures is evidenced by the high participation rates (90% + for flood proofing and 80% + for flood plain evacuation) of eligible property owners volunteering for the programs in the approved Williamson and Matewan, WV, and South Williamson, WV, nonstructural project areas. These 100% voluntary alternatives are considered to be viable and acceptable solutions to the flooding problem in the McDowell County project area.

Housing and Community Development Sites. Potential H&CD sites include Sandy Huff, Hensley # 1 and #2, Marine, Browns Creek, Elkhorn Creek, and the Toms Mountain mountaintop site. Site development costs (indexed to October 1996 price level) ranged between $27,000 to $144,000 per lot, including land, mineral rights, utility construction, and road improvement costs. The proposed sites would have established 50 to 100 housing units with the exception of the Toms Mountain site, which provided space for 1100 units. According to Bureau of Census data, McDowell County lost approximately 4000 housing units during the 1980 - 1990 period and had 2450 vacant housing units during the 1990 census consisting of primarily abandoned units which do not meet DSS requirements. The proposed project would create a demand of approximately 63 housing units per year during the seven-year implementation schedule. Since the existing housing market will not be able to absorb the project induced housing demand, last resort housing provisions of Section 206, P. L. 91-646 will be implemented as necessary, utilizing the most feasible cost effective method. Housing, of last resort, may preclude the need for H&CD sites.

Flood Insurance/Flood Plain Zoning. The combination of flood plain zoning and the National Flood Insurance Program (NFIP) can contribute to reducing financial losses due to flooding. However, in the McDowell County Project Area, the sole use of flood plain zoning and flood insurance, as a solution to flood damages is not effective. The combination of clustered development and recurring high flood damages results in frequent heavy losses to the local economy (business taxes) and many financial losses (lost business) that will not be reimbursed by flood insurance. This measure is best used in combination with other damage reduction methods and is retained for further consideration. Currently, McDowell County is enrolled in the NFIP.

Flood Warning and Emergency Evacuation Plan (FWEEP). The development, installation and operation of an effective flood warning system and a well coordinated and efficient emergency evacuation program can help reduce flood damages and the likelihood of fatalities during flooding events. Such a system allows residents and businesses the opportunity to relocate or evacuate a structure's contents and other valued property prior to flooding. However, residual damages to remaining structures and immobile facilities are not reduced by this alternative. While ineffective as a single solution for reducing flood damages, a FWEEP can be effective when used in combination with other flood damage reduction methods. Therefore, this measure was retained for further consideration.

Financial Compensation. This measure consists of providing financial compensation to eligible property owners for future damages incurred due to flooding. This measure was determined not to be acceptable as a potential nonstructural measure for McDowell County since it does not meet the dictate of Section 202 of Public Law 96-367 and is therefore not retained for further consideration.

EVALUATION

Structure Eligibility. Eligibility for either the flood proofing or flood plain evacuation measures on an individual structure basis was governed by several factors specific to the individual structure and the flooding experience of the structure. All structures that either received significant lowest, finished (habitable) floor damages in the April 1977 flood or would

receive damages in a recurrence of the April 1977 flood were considered eligible for flood proofing. Other eligibility factors include:

1) location of the structure in the floodplain;

2) depth of flooding experienced during the April 1977 flood;

3) floodwater velocities;

4) DSS status;

5) structural stability and;

6) the use of the structure.

Structures located within the regulatory floodway and structures requiring a lowest finished (habitable) floor raise exceeding twelve feet above low ground elevation around the structure were determined to be ineligible for flood proofing.

Flood flow velocities were not considered to be a significant factor in the project area affecting determination of eligibility for flood proofing. Flood flow velocities in the project area outside the regulatory floodway were estimated to be an average of 3 feet per second (fps), substantially less than the maximum velocity of 8 fps considered safe for flood proofing.

All structures eligible for flood proofing must meet certain requirements to be considered DSS. All flood-proofed structures must have a safe and potable water system. If an approved potable water source cannot be provided on site, the structure will be considered ineligible for flood proofing (or replacement-on-site) and the homeowner will be given the acquisition option. As well, all structures whether flood proofed by raising-in-place or by replacement-on-site will be connected to a State/County approved sewage disposal system. If an acceptable system cannot be provided on the lot and an alternative treatment system cannot be provided, the structure will be converted to the acquisition program.

All structures eligible for flood proofing will be evaluated during implementation to determine their structural integrity. If the structure cannot be raised and left in a structurally sound condition or if the cost of eliminating structural deficiencies increases the cost to where it no longer represents the least costly option, the acquisition-relocation or demolish and replacement on site option must be selected.

Elevation. The primary means of flood proofing eligible residential structure is by raising the structures in-place. Determination of the means of flood proofing a specific nonresidential structure is highly dependent upon the construction of the structure, its size and functional use. Access for the physically challenged, if required, would be provided for any nonresidential structure found to be eligible to be raised-in-place. The flood proofing technique for commercial structures is primarily applicable in those instances where residential type structures are used for commercial purposes or sufficient ceiling clearance exists in the structure to construct a raised floor which does not restrict business activities.

The minimum level of protection provided to those eligible for program participation is the April 1977 flood level plus one foot, or the 100-year flood level whichever is higher.

Both a cost to acquire and cost to elevate were developed separately for each individual structure eligible for flood proofing. The cost to acquire included the following: the fair market value including appropriate relocation benefits; real estate administrative costs; demolition costs (dependent upon structure type); monumentation costs; HTRW and asbestos costs (Phase I investigation, asbestos investigation, and asbestos removal); cost to improve to DSS standards; and contingencies. The cost to flood proof included the following costs: construction cost for raising-in-place (based upon a cost estimating method that uses the height of raise, the square footage of the structure, and the structure type); contingencies; engineering and design costs; supervision and administration costs; HTRW and. asbestos costs (Phase I investigation, asbestos investigation, and asbestos removal); and real estate administration costs.

Dry Flood Proofing. The viability and feasibility of flood proofing an individual nonresidential structure by means of a veneer wall is dependent upon the flood depth, flood warning time, building condition, etc. The District did conduct a preliminary investigation into the possibility of dry flood proofing nonresidential structures. Eligibility for flood proofing by means of a veneer wall on an individual structure was governed by several factors specific to the individual structure and the flooding experience of the structure. These factors included the location of the structure in the floodplain; the depth of flooding experienced during the April 1977 flood, and the condition of the structure. Based upon the criteria enumerated above, site visits, information review, and engineering judgment, four of the nonresidential sites were determined to be feasible for flood proofing by means of a veneer wall. The level of protection that will be provided to those feasible for program participation with a veneer wall is the April 1977 flood level.

Flood Plain Evacuation. Evacuation of flood prone areas can be an effective solution for reducing flood damages, especially in situations where protection in place by flood proofing options are not feasible. Therefore, all structures receiving lowest, finished (habitable) floor damages in the April 1977 flood and not eligible for flood proofing were considered to be eligible for floodplain evacuation.

Based on the previously discussed eligibility criteria, a preliminary determination was made that 278 residential and 139 nonresidential structures would be eligible for flood plain evacuation. An additional 175 residential and 10 nonresidential structures were also included in the cost to acquire as a result of the cost effective comparison

Included in the floodplain evacuation alternative are the purchases of the flood plain property (structure and lot) at fair market value, demolition of the flood-prone structure and payment of appropriate relocation benefits if the structure is occupied. This alternative is not applicable to vacant lots or structures not meeting DSS criteria. The following paragraph addresses the availability of floodsafe DSS housing in the project area.

Available Floodsafe DSS Housing in the Project Are. A replacement housing survey was completed in November 1997. The conclusion of that survey was that the proposed project would create a demand for approximately 70 dwellings per year over a 7-year period based on an 80% participation rate. The current housing market and anticipated housing market is not sufficient to accommodate the requirement. Since the existing housing market will not be able to absorb the project induced housing demand; additional measures will be evaluated under the

parameters of last resort housing contained in Public Law 91-646. The last resort housing determination will utilize the most cost-effective means to provide comparable DSS housing.

FWEEP

The least cost plan also will include the development of a Flood Warning and Emergency Evacuation Plan (FWEEP) which considers the capabilities of the National Weather Service; the Corps of Engineers; Federal, State and local emergency services agencies; rainfall recording systems; stream data gages; evacuation routes; temporary relocation shelters; coordinated police, fire and public works departments; and the integration of the entire system. This comprehensive plan would provide an efficient and effective response to future floods and their associated damage with or without a nonstructural plan being implemented.

Such efforts as identification of evacuation routes and shelters and preparation of inundation mapping depicting the various frequency levels of flooding throughout the project area, represent the major work items required. In view of the most cost-effective plan, the development and implementation of such a FWEEP would be an early action item for project implementation. Development and implementation of this plan would be accomplished by the Huntington District Corps of Engineers and is included as part of the total project cost. Operation and maintenance of this plan and established system would be considered the responsibility (and cost) of the McDowell County Commission.

Preliminary efforts have determined that the FWEEP will likely consist of five major parts: (1) Preparedness, (2) Flood Threat Recognition, (3) Warning Dissemination, (4) Emergency Response Actions, and (5) Post-Flood Recovery/Reoccupation. These sections will address the responsibility of local, state, and Federal agencies to work together in pre-flood, flood, and post-flood conditions. Maps will be included in the report, showing evacuation routes, flood zones, emergency shelters, and other important landmarks in the area.

More detailed descriptions of the FWEEP's major activities are:

1) Preparedness. Activities required prior to a flood event to ensure participants are at a sufficient level of readiness.

2) Flood Threat Recognition. Procedures to guide county officials in defining the appropriate level of flood threat and selection of the appropriate emergency response options.

3) Warning Dissemination. Procedures to notify everyone involved in responding to a flood event of the level of the threat, and the need for implementation of emergency response activities.

4) Emergency Response Actions. Delineation of emergency response actions for implementation, specification of general guidelines for selection of emergency response action(s), and determination of the organizational structure and procedures for implementation of each potential emergency response action.

5) Post Flood Recovery/Reoccupation. Identification of activities to assure an orderly and timely reestablishment of pre-flood condition, to the extent possible.

Equipment Requirements. The FWEEP will utilize the existing 13 stream gages located on the Tug Fork at such locations as Matewan, Welch, Bradshaw and Vulcan, plus other gages reported by volunteers. This provides officials with data on the changing river stages which can be used to compute rates-of-rise of the Tug Fork, and allow warning times to be calculated and permit a more organized flood evacuation effort.

Local Sponsor Responsibilities for FWEEP. It is anticipated that the local sponsor will be responsible for the following activities, at a minimum, once the FWEEP is prepared by the District:

Administrative. The County Emergency Services Director will have overall responsibility for preparedness activities in McDowell County.

Training. Training activities require that each agency and organization with a designed role in this plan be familiar with its responsibilities during a flood emergency. The head of each designated agency is assigned the responsibility for familiarizing his/her staff with the Plan and any subsequent revision to it. The importance of training is to obtain a smooth operation from each of the agencies in performing their assignments, because when a flood emergency does occur the timing of each agency is critical. The main purpose is to achieve a system of a workable plan with capable people in responsible positions. It is also important that each participant is knowledgeable and trained in the latest available technology for his or her particular role in the total plan. Participants will receive training as well as new information and technological advances.

Exercise and Drills. In order to demonstrate preparedness, the Plan will be exercised on an annual basis. An exercise will consist, at least, of a test drill of the communications network. The Plan may be fully exercised by developing a hypothetical emergency and then simulating all aspects of agency response.

Plan Maintenance. In order to keep the Plan current, it will be reviewed at least annually by the local sponsor to determine if it is still appropriate and all factual information (e.g., titles, names, addresses, telephone numbers, etc.) must be verified. Any modification made must be entered on the Record of Changes and replacement pages, dated and identified, to indicate the change must be distributed to all Plan holders.

Public Education/Information. Public preparedness for a flood emergency should be accomplished by means of a comprehensive public involvement program, to include hearings, exercises, public information releases, news releases, etc.

SELECTION OF THE MOST COST EFFECTIVE PLAN

The No Federal Action Plan or Without Project Condition does nothing to address the specific planning objectives and, given the serious nature of the flooding problem in the McDowell County Nonstructural Project area, is not considered to be viable or acceptable. The without project condition was presented in this report to serve as the base or without project condition against which to compare the remaining action plans.

The three alternative structural measures investigated include a reservoir, floodwalls, and channel modification. These three structural alternatives do not provide project wide protection and require nonstructural components to provide complete project protection in compliance with Public Law 96-367.

Nonstructural measures that have proved to be cost effective, viable approaches to reducing flood damages in the Tug Fork area are floodproofing, floodplain evacuation supplemented by a FWEEP for the project area, and strict enforcement of NFIP ordinances. The McDowell County nonstructural alternative is based on those measures.

The remaining alternative is a variant of the nonstructural alternative, which includes construction of H&CD sites to provide building sites for project participants. This alternative includes all other features of the nonstructural alternative.

The five alternatives identified above where then evaluated by comparing each alternative to the planning objective. A brief narrative of each evaluation by objective is listed below and summarized in Table 1. The evaluation of each alternative to the identified objective in Table 1 consists of "Yes" if the alternative meets the objective or "No" if it does not.

Most Cost Effective Plan. The nonstructural alternative was found to be the most cost-effective method of providing flood protection to the McDowell County Project Area. The reservoir alternative was significantly more expensive than the nonstructural alternative and it only provides protection to 35 of the project's 988 structures; the remaining structures would receive nonstructural protection. The floodwall alternative was evaluated at twelve community centers in the project area and found to be more expensive than the nonstructural alternative alone because construction of floodwalls did not significantly reduce the number of structures to be acquired or flood proofed. The channel modification alternative was more expensive than the nonstructural project because of construction costs for the channel modification and because construction right-of-way requirements would result in acquisition of most of the structures requiring protection. The nonstructural with H&CD sites alternative is also more expensive than the nonstructural alternative because housing site development costs exceed the anticipated relocation benefit cost for assisting project participants move to properties in existing communities.

Reduce Financial Loss to Property Owners. All alternatives meet this objective because all are designed to protect to the April 1977 flood level.

Maintain Cultural Resources. All alternatives were formulated to meet applicable federal and state laws governing protection of significant historical or archaeological sites.

Minimize Social/Economic/Disruption. Implementation of the nonstructural alternative results in minimum social and economic disruption when compared to the other alternatives. The reservoir alternative would essentially have the same impact as the nonstructural alternative, with the exception of construction activities in the proposed reservoir area which would disrupt recreation and logging activities in Panther State Forest during construction and require construction of new roads and state forest office facilities. The floodwall alternative would result in acquisition of significant numbers of structures for construction and right-of-way purposes and seriously impact traffic through the community during construction, due to linear development patterns in the communities. The channel modification alternative would have the

same disruptive effect as the floodwall alternative with additional disruptions for road and railway relocations. The nonstructural with H & CD sites alternative would have the same impact as the nonstructural alternative with additional impacts due to depopulation of existing communities. These impacts include loss of utility customers for existing water companies, loss of customers for existing commercial enterprises, and loss of community identity.

Most Socially and Environmentally Acceptable Plan. The voluntary nonstructural alternative has the least social and environmental impact on the project area. The reservoir alternative would cost significantly more than the nonstructural alternative for the same level of protection and adversely effect the current operation of Panther State Forrest. Construction of the floodwall or channel modification alternatives would require a major property acquisition program for construction and right-of-way, which would result in a loss of most of the structures we are attempting to protect. The nonstructural with H & CD sites alternative would cost more than the nonstructural alternative, would disrupt existing communities, require construction of housing sites, and construction of new infrastructure.

Given the array of alternatives evaluated and planning objectives, protection of the McDowell County Project Area by means of the structural alternatives or use of H&CD sites is not cost effective or is otherwise infeasible. Consequently, the most cost-effective plan is composed of nonstructural measures and this report has defined the least cost combination of flood proofing and flood plain evacuation.

Table 1

COMPARISON OF ALTERNATIVES TO PLANNING OBJECTIVES

Alternative/ Objective	Reservoir (1)	Floodwall (1)	Channel Modification (1)	Nonstructural with H&CD Sites	Nonstructural
Most cost Effective Plan	No	No	No	No	Yes
Reduce Financial Loss to Property Owners	Yes	Yes	Yes	Yes	Yes
Maintain Cultural Resources	Yes	Yes	Yes	Yes	Yes
Minimize Social/Economic Disruption	No	No	No	No	Yes
Most Socially and Environmentally Acceptable Plan	No	No	No	No	Yes

(1) Structural alternatives include nonstructural components to provide April 1977 flood level protection to entire project area

THE MOST COST EFFECTIVE PLAN

Project Features. The most cost effective, implementable plan, which satisfies the established planning objectives, is a comprehensive flood damage reduction plan consisting of a voluntary flood proofing and flood plain evacuation program in conjunction with a Flood Warning Emergency Evacuation Plan and continued participation in the National Flood Insurance Program. Table 2 shows the disposition of the total structures in the project area by structure type and program eligibility.

TABLE 2

Cost Effective Plan
Disposition of Project Area Structures
By Structure Type and Program Eligibility

Program Eligibility	Residential	Nonresidential	Relocation Contract	Total
Elevation	**345**	**20**		**365**
Dry Flood Proofing		**4**	**4**	**8**
Flood Plain Evacuation	**453**	**148**	**14**	**615**
Total	**798**	**172**	**18**	**988**

All property would be acquired under authority of Section 202 with relocation assistance payments determined in accordance with provisions of the Uniform Relocations Assistance and Real Property Acquisition Act of 1970 (Public Law 91-646).

Residual Damages. Inherent in the nonstructural program are residual flooding damages to the residences, businesses, utilities, highways, etc., that remain in the area after completion of the project. The flood proofing of structures raises them above the designated flood elevation, but powerlines, utility lines, roads, garages, outbuildings, warehouses etc., remain at their original level. These will still sustain damages during floods. Additionally, since flood proofed structures must be evacuated during flooding events, there is always the possibility of structural damages from floating debris. Flood proofed structures must then have the areas that were inundated cleaned and any deposited debris removed. Since the program is voluntary, there will also be damages to those structures whose owners elected not to participate in the program.

PROJECT IMPLEMENTATION

General. The District has developed specific nonstructural policies, based upon experience gained during the ongoing nonstructural activities being implemented in the approved Section 202 project areas, to guide implementation of the plan in direct response to project objectives identified by authorizing legislation. These policies have been summarized as:

1) Participation in the nonstructural program is voluntary.

2) The only options available for owners of structures located in the floodway and those structures requiring elevation of 12 feet or greater above low ground elevation are acquisition or nonparticipation.

3) The most cost-effective alternative, flood proofing or flood plain evacuation,

will be offered to owners eligible for flood proofing. Homeowners may choose to buy-up the flood proofing option if all criteria are met.

4) When last resort housing is required to provide DSS housing for the flood plain evacuees, the most cost-effective relocation alternative available at that time will be utilized.

5) Relocation sites will not be offered to residential flood plain evacuees unless required under Public Law 91-646 parameters.

6) Vacant lots will not be acquired. Restrictions on flood plain development contained in the PCA and in the existing flood plain ordinances administered and enforced by McDowell County will control development of vacant property to prevent future development subject to flood damage.

Project Costs. The total project cost is estimated to be $172,200,00 (fully funded).

The McDowell County Nonstructural Project is subject to the cost-sharing requirements of Public Law 99-662 (the 1986 Water Resources Development Act). Any flood project or separable element subject to the cost-sharing provisions of Public Law 99-662, requires an "Ability-to-Pay" determination in accordance with Section 103 (m) of the Act.

Under the ability-to-pay determination-based on State and County per capita income-the McDowell County Project Area is eligible for a full reduction.

Therefore, the non-Federal share is 5 percent or approximately $8.6 million (Fully Funded). The Federal share is 95 percent or approximately $163.6 million (Fully Funded).

Project Sponsorship. A Project Cooperation Agreement (PCA) will be executed between the Corps of Engineers and the non-Federal sponsor, the McDowell County Commission. As defined in the agreement, the County Commission, will then serve as the non-Federal cost-sharing sponsor for the project, providing the required 5 percent non-Federal share. The following summarizes the contractual obligations of the McDowell County Commission as the non-Federal co-sponsor for project implementation.

- Provide the non-Federal cost-share of the project.
- Satisfy the O&M requirements of the project.
- Enforce Flood Plain Ordinances.
- Operate and maintain the FWEEP.

Available Flood Safe DSS Housing in the Project Area. Throughout McDowell County repeated flooding has severely impacted the quality and structural integrity of the flood plain housing stock, which in a large percentage of the cases is not detectable without a thorough inspection of the individual structure. A last resort housing analysis has been performed in the McDowell county Project Area as a part of the Real Estate Plan. This report determined that the

implementation of surrounding projects has further depleted the DSS housing stock as those residents who have their property acquired have relocated within the same area. As a result of the District's experience with other projects, authority has been requested for last resort housing on a project wide basis but will be implemented on a case-by-case basis due to an apparent lack of DSS housing in the project area.

Under last resort housing, a number of alternatives will be considered and utilized where applicable. These alternatives include but are not limited to the use of replacement housing supplemental payments exceeding $22,500. In all cases the least expensive alternative will be used.

Disposition of Evacuated Flood Plain Properties. It will be the responsibility of the non-Federal sponsor to determine the use of lands evacuated as a part of the flood plain acquisition program. Appropriate deed restrictions will be recorded on those lands deemed to be excess and sold by the local sponsor. These deed restrictions will restrict development in the flood plain and the area below the April 1977 flood.

Flood Proofing O&M. Each structure flood proofed will have a Flood Proofing Agreement recorded in the property deed which includes provisions for the prevention of living space with development in flood prone spaces created by the flood proofing process. The McDowell County Commission will assume the responsibility to assure each structure owner properly maintains the flood proofing features of the structure and also complies with all requirements of the County flood plain ordinances. The non-Federal sponsor will provide annual certification to the Corps that the items of O&M regarding flood proofed structures have been addressed per the flood proofing agreements.

OMRR&R Costs. Subject to the terms of the PCA, the sponsor is required to provide an annual report to the District on the compliance with the nonstructural program objectives by the program participants. This effort will be accomplished by the McDowell County Flood Plain Coordinator. It is anticipated that the additional costs for accomplishing this activity are minimal since the Coordinator was previously tasked with inspection requirements for the County's participation in the National Flood Insurance Program. The County Commission recognizes their responsibility to prepare the report and has agreed to furnish this report to the District on an annual basis.

CONCLUSION

This Detailed Project Report describes the project elements determined to be necessary and advisable to reduce future flood damages in the McDowell County Project Area. The most cost effective plan was found to be effective in reducing flood damages, cost-effective in relation to other alternatives considered, and both socially acceptable and environmentally suitable. The cost effective project satisfies the legislative requirements of both Section 202 of the 1981 Water and Energy Development Appropriations Act (Public Law 96-367), the FY 84 Urgent Supplemental Appropriations Act (Public Law 98-332), and the FY 98 Appropriations Act (Public Law 105-62).

Although the cost-effective plan does provide flood protection for the unprotected increment of the Tug Fork and it's major tributaries within McDowell County, this plan does not meet the current Corps economic criteria for water resource projects and is therefore not supported by the Administration. Therefore, funding for this project must be provided through direct Congressional appropriations on an annual basis.

HUNTINGTON DISTRICT
STANDARD OPERATING PROCEDURE (SOP)
FOR
IMPLEMENTATION OF SECTION 202 FLOODPROOFING PROGRAM

A. FLOODPROOFING PROGRAM - GENERAL

1. References (Appendix l):

a. Section 202 of Public Law 96-367 (October 1980), authorizing design and construction of flood protection measures within the Tug Fork Valley (and other areas) as considered necessary and advisable.

b. CEORDR-1105-2-4, Section 202 (March 1992)

c. Project Procedures Manuals (Not included in Appendix 1)

d. Design and Technical Criteria (Residential /Nonresidential)

e. Miscellaneous authorizing documents, policy letters, Project Cooperation Agreements (PCA), Memorandum Of Agreements (MOA) and memoranda that provide guidance for implementing the floodproofing program.

2. Purpose of the SOP - The purpose of this SOP is to provide the District with a set of clearly defined procedures consistent with cited references for administration and implementation of the Section 202 Floodproofing Program. This SOP will assist in maintaining program consistency among projects. The SOP will describe each step involved, from the landowners meeting to structure turn over to the local sponsor for operation and maintenance. It will also describe program management responsibilities and provide a systematic approach so that internal controls can be put in place and documented.

The procedures set forth for the preparation of the Independent Government Estimate (IGE), solicitation of construction proposals, negotiations and award will generally apply the principles of the FAR, engineering manuals and circulars in that all efforts will be made to eliminate the potential for waste, fraud and abuse. A direct application of the specific requirements of these regulations are not required since payment for floodproofing construction is made utilizing standard Real Estate contracts and not through the normal Government contracting procedures. Real Estate contracts are not subject to FAR.

The floodproofing program will be implemented utilizing the policies and procedures described herein to provide flood protection to an area that has been devastated by repeated flooding. In accordance with criteria hereinafter set forth, flood protection will be provided to those structures that would be damaged by a recurrence of the April 1977 flood event.

3. Floodproofing Eligibility - Eligibility for the floodproofing program is based on a structure being subject to receiving first finished (habitable) floor damages as a result of a

recurrence of the April 1977 flood. A structure's first finished (habitable) floor must be at or below the April 1977 flood level and be subject to receiving significant structural and/or content damages to be eligible for the floodproofing program. Structures that have nonhabitable basements containing utilities (i.e. hot water tanks, washers/dryers and refrigerators) that are subject to flooding by a recurrence of the April 1977 flood are not eligible unless the first finished (habitable) floor of that structure meets the above criteria. Structures meeting the above criteria that are located in the regulatory floodway or those that would require a raise in excess of twelve feet above low ground elevation are only eligible for the acquisition program. During the preparation of the Detailed Project Report (DPR), preliminary cost estimates are developed for both floodproofing and acquisition and then compared to determine the least costly of the two. If it is more cost effective to acquire the structure, then it is eligible for voluntary acquisition only. Generally, this cost comparison will not be re-evaluated; however, there may be circumstances discovered during implementation that would warrant a review of that decision (i.e. a challenge of the data by the homeowner or additional information that may be discovered by the implementation team). Specific structure analysis to determine structural feasibility for floodproofing is made during implementation of the project. During implementation, a structure identified within the DPR as eligible for the floodproofing program may be converted to the acquisition program due to structural or decent, safe and sanitary (DSS) considerations. This proccess will be discussed in more detail in Section D.8.

4. Floodproofing Program Components - The floodproofing program consists of providing flood protection to those structures that meet the criteria described in Section A.3. That protection can be accomplished by any one of the following methods or combination thereof as determined to be the most cost effective for that particular structure. The program components available for implementation are described below and are used in accordance with established design criteria.

a. Wet Floodproofing Methods

1. Raise-in-place - Raise structure at its existing location on an elevated foundation or piers. The existing footer and/or foundation may be used depending on its condition.

2. Move on site - Due to structural reasons or cost effectiveness, a structure may be moved to a higher location on owners contiguous property which may require a lesser raise. This decision will be made by the implementation team on a structure specific basis during the site investigation.

3. Replacement - When the implementation team determines that a structure cannot be floodproofed due to structural deficiencies, they may evaluate demolition of the existing structure and replacement with a new elevated structure, comparable in size to the existing structure. The cost for the replacement option must be less than the cost of acquisition plus standard relocation benefits before it will be considered a viable alternative.

b. Dry Floodproofing Methods

1. Veneer Walls - Construction of a waterproofed wall attached to the structure with sealed openings at all entrances. Normally, veneer walls requiring a height greater

than four feet will not be considered. This option would generally be reserved for masonry structures in sound condition.

2. Ringwall/levee - A ringwall or levee may be constructed to protect an individual structure or small group of structures. In the event that a ringwall/levee is used, the traditional process would be followed for design and construction.

c. Other Methods

1. Owner Replacement - An owner has the option to take the Government offer for raising his/her existing structure and replacing it with a new floodproofed structure. The owner would be responsible for demolition of the existing structure and replacement with a new elevated structure which meets the floodproofing criteria. The owner would be responsible for all costs that exceeds the Government offer.

2. Miscellaneous - The implementation team shall have the flexibility to consider other methods of providing flood protection in the event of unique situations. Whichever method is used, it must be the most cost effective alternative and it must meet all applicable floodproofing criteria.

B. FLOODPROOFING PROGRAM MANAGEMENT

Responsibility for management of the Floodproofing Program rests with Floodplain Management/Special Studies Branch in Planning Division (PD-S). The Chief of PD-S has been designated as the Floodproofing Program Manager (FPM). The FPM has complete authority and responsibility for implementing the floodproofing program within the guidelines established herein utilizing manpower resources dedicated to the floodproofing program by PD-S and in coordination with other functional elements.

In January 1993, the District Project Review Board approved the establishment of a floodproofing implementation team which would work under the oversight of the FPM. The implementation team concept departed from the traditional procedures utilized by the District in that the team operates primarily independent of the functional element chain of command. This concept removes many of the constraints and delays inherent in the prior formal process of tasking individual functional elements for each needed task. The team concept is utilized primarily for residential floodproofing; however, non-residential floodproofing may also be implemented by the team concept for typical floodproofing methods. If ringwalls, levees or other unique methods are required, the traditional process will be followed. Exhibit 1 shows the organizational structure of the floodproofing implementation team and it should be noted that additional teams may be added as required to meet project schedules and workload. Although members assigned to the floodproofing implementation team work at the direction of the FPM, they remain under the direct supervision of their individual functional chiefs.

Each team consists of a team leader, designer, cost engineer, construction inspector and a real estate attorney. The general responsibilities of each member are described below, while specific responsibilities are described in Section D. The responsibilities of the FPM have been discussed previously.

1. Floodproofing Program Coordinator (FPC) - The FPC works directly under the supervision of the FPM and is assigned to PD-S. The FPC serves as a member of the project management team, project coordination team and also serves as Acting FPM in the FPM's absence. The FPC is responsible for administration, scheduling and budgeting for the floodproofing program based on the approved Detailed Project Reports and PMP's. The FPC coordinates the activities of each implementation team, is responsible for negotiations (when necessary) and may serve as a team leader. In the absence of the FPM, the FPC will have the authority to sign correspondence and requesting approval memoranda on behalf of the FPM.

2. Team Leader - The team leader will serve on the project management team and is responsible for preparing monthly status reports, scheduling the activities of the implementation team, and all coordination with the homeowners and contractors. The team leader is also responsible for documenting the activities of the implementation team and assuring that the official structure files are maintained.

3. Designer - The designer is responsible for evaluating each structure, collecting necessary site data, preparation of Guide Plans and Specifications (GP&S), preparation of material quantity take-offs for the cost engineer, and review of construction change orders. The designer will participate in negotiations as an advisor to the FPC as necessary.

4. Cost Engineer - The cost engineer is responsible for the preparation and handling of the Independent Government Estimate (IGE) for each structure and review of all construction proposals and change orders. The cost engineer will also participate in any negotiations to assist the FPC. The cost engineer will perform these responsibilities in accordance with the procedures described in Section C.

5. Construction Inspector - The inspector is responsible for providing periodic inspections during the floodproofing construction to assure that the construction is in accordance with the GP&S and that standard construction practices are being followed. The inspector participates at the final inspection and must approve the construction before payment can be made.

6. Real Estate Attorney - The real estate attorney is responsible for performing title searches to verify ownership, identify lienholders, prepare floodproofing agreements and consents, discuss and explain provisions of floodproofing agreements, modifications, consents and subordinations with owners and lienholders. He/she is also responsible for securing execution of floodproofing agreements, modifications, consents and subordinations and update title searches prior to closings. The real estate attorney will conduct closings and record floodproofing agreements and modifications in land records.

C. **PREPARATION AND HANDLING OF THE INDEPENDENT GOVERNMENT ESTIMATE (IGE)**

1. Independent Government Estimate - The IGE is the formal, approved construction cost estimate prepared by the cost engineer, using Military Computer Aided Cost Estimate System (MCACES), to support the Government's offer to the homeowner for floodproofing their structure. It is used to evaluate Contractor proposals and assist in negotiations if necessary. Sample signature pages and supporting documentation for revisions to the IGE are included as Appendix II. The IGE is based on the Guide Plans and Specifications (GP&S) prepared by the designer and utilizes the following parameters:

a. Overhead and Profit - Overhead rates included in the IGE are based on a composite of "post" construction audited data and are generally 10% for work performed by the prime contractor. For work to be performed by sub-contractors, the prime contractor may add overhead equal to one-half of the negotiated rate. The IGE will not include profit.

b. Take-off's - The Designer will provide a complete quantity take-off to the cost engineer prior to delivery of the GP&S to the homeowner. The cost engineer shall review the take-offs to ensure the correctness thereof.

c. Labor Rates - The labor rates used in preparing the IGE shall be the average of the audited rates found during the pre and post audits of selected contractors in the project area. Davis-Bacon rates are not required but may be considered as guides.

d. Equipment Rates - The equipment rates shall be based on rates published in EP 1110-1-8 and adjusted for the area using the pre- and post-audited rates.

e. Material Rates - The cost engineer shall request material prices from local suppliers approximately every six (6) months or as often as price changes dictate, whichever is sooner.

f. Sub-Contract Work - Some bid items including lifting (HVAC, aerator systems, chair lifts, asbestos removal, etc.) will require quotes from suppliers for complete installation. The cost engineer will keep a current file of local suppliers or lifters for use in obtaining quotes. Since overhead and profit for the subcontractors will be included in their quote, no additional overhead or profit shall be added to that quote; however, the prime contractor's overhead will be as outlined in c.1.a. above.

2. Completed IGE - The IGE is considered a fair and reasonable (not necessarily the lowest possible cost) cost for a local contractor to complete the work as prescribed in the GP&S. The procedures outlined herein and supplemented by other Government regulations will result in uniformity and accuracy in the IGE and will protect the Government against excessive cost for the said work. The completed IGE shall be furnished to the FPM or his designated representative and designated **"FOR OFFICIAL USE ONLY"** until the FPM receives the construction proposals from the homeowner. An allowance for an extension of the submittal due date may be granted by the FPM in extenuating circumstances. The IGE will consist of:

a. Title Page - A sample title page is included in Appendix II and will be stamped with the appropriate stamp:

"FOR OFFICIAL USE ONLY
This protective marking is canceled upon award of contract or on whichever is earlier." _____ (Date)

b. Signature Page – The signature page will include the due date of the IGE, the structure number, owner name, tract number and total cost and will be signed and dated by Chief, Cost Engineering Branch and Chief, Engineering Division. A sample signature page is included as Appendix II and will be stamped **"FOR OFFICIAL USE ONLY"**.

c. Bid Schedule – It includes the total estimated cost of all items, as well as the structure owner, tract number and structure number and shall be stamped **"FOR OFFICIAL USE ONLY"**.

3. Proposals for Replacement by Homeowner – In the event that upon delivery of the GP&S (for floodproofing the existing structure), the homeowner advises the team leader that they want to replace their existing structure with a new floodproofed structure, supplementing the government offer with their own funds, the requirement for soliciting contractor proposals will be waived. Instead, the homeowner will be provided the government's official offer based on the GP&S for floodproofing the existing structure. The homeowner would be responsible for all costs exceeding that offer. The Government will not participate in negotiations under this scenario.

4. Receipt of Contractor Proposals - Upon receipt of the proposals from the homeowner, the FPM or his designated representative will add the date to the Title Page Stamp, 2.a. above and furnish the cost engineer a copy of the marked IGE along with copies of all proposals received from the homeowner. The cost engineer will then evaluate the proposals and, based on that evaluation, will furnish the team leader with the results of his evaluation. The "Official Offer", based on the cost engineers evaluation, will generally be either the lowest proposal (if determined to be responsive) or the IGE, whichever is lowest. Exceptions to this are discussed below.

5. Negotiations - In the event that the Government offer is less than each of the submitted proposals, the homeowner may request the Government to participate in negotiations with a contractor on their behalf. Prior to the negotiations, the FPC will request the cost engineer to furnish areas of the proposal where the contractor may need to re-evaluate. The FPC will then use this information to conduct the negotiations. The contractor must bring to the negotiations a complete breakdown of his labor, equipment and material by bid item so a comparison can be made between the IGE and the contractor's proposal. The FPC, with the assistance of the cost engineer and designer will lead the negotiations. Negotiations may be held by telephone, in the field or in the District office. During the course of the negotiations the FPC may direct the cost engineer or designer to re-evaluate an area of the IGE where differences between the IGE and the contractor's proposal cannot be resolved. The results of the negotiations will be fully documented in the form of a Memorandum Of Record (MFR) prepared by the FPC. The MFR will describe those areas where the cost engineer has bee directed to re-evaluate and where the contractor has agreed to re-evaluate. A copy of the MFR will be provide to the cost engineer

with the original being placed in the official file. If the results of the re-evaluation justify a revision of the IGE, the cost engineer will follow the steps shown below.

6. Re-evaluation of the IGE – The FPM or his designated representative directs the cost engineer to re-evaluate the IGE. An example of the items which may be considered by the FPC for re-evaluation are materials, labor, quantities and equipment. A complete narrative documenting the re-evaluation will be included in the Project Notes of the MCACES estimate and be signed and dated by Chief, Cost Engineering Branch showing the total amount of the IGE including revisions. Said documentation will include but not be limited to, date of re-evaluation, reason for re-evaluation, basis for decision, supporting analysis and the effects on the IGE. The signed document will be furnished the FPM and included as part of the OFFICIAL file which shall be maintained by PD-S (sample included in Appendix II).

7. Official Government Offer – In accordance with the above actions, the "Official Offer" will be determined by the FPM under the following situations:

a. In those cases where the contractor's proposal has been determined by the cost engineer to be responsive and either equal to or less than the IGE, the FPM shall have the authority to make an Official Offer to the homeowner equivalent to the contractor's proposal, without any negotiations. In the event that several proposals are received that are at or below the IGE, the FPM shall have the authority to make the offer based upon the lowest responsive contractor's proposal.

b. In those cases where the contractor's proposal is greater than the IGE, the FPM shall have the authority to proceed in the best interests of the Government under one of the following procedures:

1. Make an Official Offer to-the homeowner based upon the IGE.

2. Participate in negotiations (see Section C.5. above) with the contractor at the homeowner's request, and as a result of those negotiations, re-evaluate the IGE and make an Official Offer based upon a revised IGE or make an Official Offer without revision of the IGE (see, C.7.b.1)above).

3. Make an Official Offer which exceeds the IGE (without revising the IGE in accordance with Section C.6. of this SOP). This authority shall be limited to less than 15 percent in excess of a fair and reasonable estimated cost (IGE) of a well equipped contractor doing the work. The FPM shall only use this discretionary authority when such action is in the best interests of the Government and the Floodproofing Program. In no case shall the FPM make an Official Offer that exceeds the IGE by 15 percent or more. In the event the FPM uses this discretionary authority, it must be documented by a MFR for the official structure file.

4. Participate in negotiations with the contractor at the homeowner's request and as a result of those negotiations, make an offer which exceeds the IGE (in accordance with C.7.b.3.).

D. **FLOODPROOFING IMPLEMENTATION PROCEDURES**

1. Program Announcement - Upon approval of the DPR by the Assistant Secretary of the Army (Civil Works), allocation of project funds for implementation and execution of the PCA and MOA, Real Estate Division (RE) will conduct a landowners meeting to announce the initiation of the program and to explain program options with eligible property owners. Planning Division will assist with the meeting to explain the floodproofing program. Depending on the size or complexity of a project, it may be necessary to implement the project in phases; in such a case, separate landowners meetings will be conducted to initiate implementation of each phase.

2. Receipt/Verification of Floodproofing Applications

a. Receive application - The Real Estate Project Office (REPO) will receive applications from all eligible participants who desire to participate.

b. Assign priority - The REPO will number the applications in the order of sign-up. Unique situations may occur where an applicant may not be processed in the assigned order. An example would be where an applicant had deed problems or judgments against the property or where it is more expedient to evaluate a group of structures located in the same general area.

c. Notification of Assessment - In areas where the local sponsor requires the participants to pay a share of the project costs, the local sponsor will provide the REPO with verification of assessment. This verification is required for participation. If advised by the Local Sponsor that an assessment has not been made, the REPO will notify the homeowner that they must be assessed.

d. Verify Ownership - The REPO attorney will review county records to verify ownership and identify lienholders.

e. Ownership Search - Once ownership is verified, the REPO will conduct a ownership search for the past sixty years to assist in Phase I HTRW/Asbestos investigations. Information relative to the ownership search will be provided to Engineering Division (ED).

f. Accept Applications - The REPO attorney will submit the applications along with appropriate documentation to the Chief, RE, for acceptance of each application.

g. Forward Applicatons to Flood Proofing Program Coordinator – Once the applications have been accepted, RE will forward copies to the FPC and furnish each owner a copy.

3. Develop Implementation Team Work Schedule – The FPC (PD-S) and team leader(s) shall develop work schedules for the implementation team(s) in accordance with approved project schedules following receipt of approved applications from RE.

4. Phase I HTRW/Asbestos Investigations - Upon receipt of the accepted application, the floodproofing program coordinator will task ED to initiate Phase I HTRW/asbestos investigations for those structures for which applications have been received. The final results of these investigations will be documented and submitted to the program coordinator in report form.

Interim results will be provided to the program coordinator as investigations are completed so that project implementation will not be delayed. In no case will the owner be provided with a set of GP&S until the results of these investigations are known.

5. Cultural Resources Evaluation - The FPC will task PD-B to conduct a cultural resources reconnaissance of all eligible structures included in the floodproofing program. If any structure is determined to be eligible for the National Register of Historic Places by the cultural resources reconnaissance, PD-B will determine the procedures that must be followed to be in compliance with Section 106 of the National Historic Preservation Act.

6. Sanitary Disposal Requirements - Floodproofing program policy requires that each structure floodproofed have an approved sanitary disposal system. In that regard, the FPC will provide the county sanitary engineer with a list of structures that are going to be floodproofed. The county engineer will advise the FPC of the requirements needed for each structure to be in compliance with local and state health codes.

7. Homeowner Coordination/Scheduling - The team leader (PD-S) will be responsible for homeowner/contractor coordination, implementation team coordination, scheduling of site inspections, delivery of GP&S, and final inspections.

8. Site Inspections - A site inspection will be conducted for each structure for which an accepted application has been received. The purpose of the inspection is to gather all pertinent information for preparing GP&S for floodproofing the structure. The implementation team leader will be responsible for explaining to the owner(s) how the program works, what their options are depending on the outcome of the inspections and to answer any questions that the owner may have. The team leader will also attempt to gather information relative to temporary housing needs the owners may have and whether they have any liens against their property. The designer will inspect the structure to determine its structural condition and document any technical information required to prepare the GP&S for floodproofing the structure (i.e. measurements, type of foundation, floor system, etc.). The team will photograph and video all aspects of the structure. Based on the results of the inspection, the team will determine the structural feasibility for floodproofing. If the structure cannot be raised, other methods must be evaluated. The implementation team shall determine the most cost effective method for floodproofing the structure based on program guidelines and floodproofing criteria. All decisions are to be clearly documented in the official structure file maintained by PD-S. If a structure cannot be raised due to structural deficiencies, the implementation team must evaluate the cost of providing a replacement structure against that of acquisition. An example of the cost comparison analysis can be seen as Appendix III. If the structure cannot be provided an approved sanitary disposal system or with safe potable water, the structure must be converted to the acquisition program. Any change in program options will be documented by memorandum to RE by the FPM.

9. Preparation of Homeowner Package/Guide Plans and Specifications (GP&S) (Appendix IV*)* - The designer is responsible for preparing the GP&S which is made up of the scope of work, site plan, foundation plan, applicable details, specifications and sample bid proposals. Upon completion, the designer will submit the GP&S to the team leader for review and incorporation into the Homeowner Package. At the same time the designer will submit the material quantity takeoff to the cost engineer for preparation of the IGE. The team leader is responsible for preparing the homeowner/contractor messages and assembling the entire

homeowner package. The homeowner package includes a message to the homeowner/contractor, the GP&S, elevation certificates, description and location of benchmarks and a list of contractors that have expressed an interest in participating in the floodproofing program. The contractors list is provided only as an aid to the homeowner and does not represent a recommendation or endorsement of the contractors.

10. Deliver Homeowner Package - The team leader and designer will deliver the Homeowner Package to the participating homeowner.

a. Determine Temporary Housing - The District's floodproofing policy requires that a homeowner vacate the structure during construction as a safety precaution. The designer is responsible for determining the length of time that the homeowner must vacate the structure. The normal floodproofing construction period is 60 days, of which the Corps will allow a reasonable amount for expenses that a homeowner incurs over and above their normal living expenses during that period. During the initial site visit, the team leader will discuss the temporary housing needs with the homeowner and requests the homeowner to determine his/her needs by the time the Homeowner Package/GP&S are delivered. If the homeowner cannot determine his/her temporary housing needs by delivery of the GP&S, the team leader will establish an amount based on program experience for similar situations. If the homeowner finds that the amount established by the team leader is not sufficient to cover his/her additional expenses, he/she may provide written documentation with the contractor proposals supporting the additional allowance. Once the housing allowance has been established, the team leader will provide the agreed upon amount to the cost engineer to include in the IGE.

b. Homeowner Responsibilities - The Message to the Homeowner included in the Homeowner Package describes in detail the responsibilities of the homeowner. Basically, the homeowner reviews the GP&S, and, if acceptable, solicits three construction proposals to submit to the FPM, selects the contractor, negotiates the price (if required) based on Government offer, executes the Floodproofing Agreement with the Corps, executes the construction contract with contractor, gives notice to proceed to the contractor, inspects the construction, notifies the team leader of any changes to scope of work during construction and approves the final construction. The homeowner is also responsible for advising the team leader of his/her intent or desire to add betterments which will be at his/her expense.

c. Contractor Responsibilities - As above, the contractor responsibilities are described in detail in the Message to the Contractor. Basically, the contractor, upon request from the homeowner, inspects the structure to help him/her in preparing the construction proposal, negotiates with the homeowner (if required), executes the construction contract with the homeowner, performs the floodproofing construction in accordance with GP&S and provides the homeowner with certified elevation certificates.

11. Solicitation of Construction Proposals - Once the homeowner has reviewed and accepted the GP&S, he/she is responsible for soliciting a minimum of three construction proposals from any contractor of his/her choice provided the contractor meets the business and/or contractor licensing requirements of the State or Commonwealth where the project is being implemented. Although the homeowner is strongly encouraged to submit three proposals, one will be acceptable. The team leader will explain to the homeowner that multiple proposals may increase their chance of receiving a proposal acceptable to the Government. The homeowner is asked to submit his/her proposals to the Floodproofing Program Manager (FPM)

within 14 days from the date of delivery of the GP&S. Allowance for an extension of the submittal due date of the construction proposals may be granted by the FPM in extenuating circumstances.

12. Preparation of Independent Government Estimate (IGE) - Once the GP&S have been delivered, the cost engineer will prepare the IGE while the homeowner is soliciting construction proposals. The IGE will be prepared in accordance with the previously described policy and provided to the FPM upon completion (see Section C.).

13. Review Construction Proposals - The homeowner is required to submit all construction proposals obtained to the FPM (see Section C.4.).

14. Official Government "Offer" to Homeowner - The team leader will advise the homeowner by telephone of the official Government "offer" (including temporary housing) for having his/her home floodproofed. This verbal notification of the official Government offer is subsequently confirmed by certified letter to the homeowner (Appendix V).

15. Negotiations if Requested by Homeowner -The homeowner is responsible for all negotiations with the contractor. However, the homeowner may request assistance from the FPM in negotiating (see Section C.5.).

16. Request for Floodproofing Agreement - Upon notification by the homeowner that he/she has reached an agreement with his/her contractor, the team leader will request (by memorandum) that RE prepare a draft floodproofing agreement. A sample memorandum is included as Appendix VI . The team leader will fax a copy of the official memorandum to the REPO in order to expedite the process.

17. Execution of Floodproofing Agreement - Once the draft floodproofing agreement (Appendix V11) is prepared, the homeowner is contacted by the REPO attorney to schedule a date for execution of the agreement. The team leader will be notified by the REPO attorney when the floodproofing agreement has been executed. The contractor is not a party to the floodproofing agreement, however; if there are any liens against the property, the lienholders must subordinate their interest in the property by being a party to the agreement as well.

18. Acceptance of Floodproofing Agreement - The REPO attorney will submit the executed copy of the floodproofing agreement to the Chief, RE for acceptance. Once the floodproofing agreement has been accepted, RE will notify the team leader and provide the homeowner with a signed copy of the agreement by letter (see Appendix VIII) which gives him/her authorization to proceed with having his/her home floodproofed. A copy of the letter including an original signed copy of the floodproofing agreement is provided to the team leader. The team leader will give the homeowner advance notification by telephone that the agreement has been accepted. Once the floodproofing agreement has been accepted, RE will request that a check be prepared for full payment upon completion of the floodproofing construction.

19. Execution of Construction Contract - Upon notification that the floodproofing agreement has been accepted, the homeowner and contractor will execute a construction contract. The Government is not a party to the construction contract.

20. Notice to Proceed - The homeowner is responsible for providing his/her contractor with the notice to proceed with construction.

21. Construction - Upon being provided the notice to proceed for construction, the contractor will proceed with construction in accordance with the GP&S.

22. Floodproofing Construction Inspections - The team leader will notify Construction Division (CD) by memorandum that the floodproofing agreement has been executed. The memorandum will include a copy of the GP&S and the anticipated date for initiation of construction. The team leader will advise the CD inspector of any additional work that the homeowner may want accomplished by his/her contractor. Any changes requested by the homeowner must meet the floodproofing criteria and any additional cost over and above the official Government offer for that work must be borne by the homeowner.

The CD inspector will visit the construction site during the lifting of the structure to ensure that safe and proper lifting techniques are being performed. When the structure is raised-in-place, a safety inspection of the underside of the house is then done to help prevent injuries from failing debris. The inspector will observe the excavation and pouring of the footings to assure that proper dimensions and depth as well as installation of reinforcing steel and concrete in compliance with the GP&S. Periodic inspections will continue through the remainder of the work to assure that proper materials and techniques are being utilized according to standard construction practices. The GP&S are utilized during each phase of inspections to assure that the contractor is in compliance.

23. Change Orders - Change orders are to be discouraged; however, there will be occasions when unforeseen circumstances arise making it necessary for the homeowner to request a change order. All changes must be coordinated with the team leader or construction inspector and approved by the FPM or his designated representative before the change is initiated. The implementation team designer and cost engineer shall review the requested change to determine it's necessity and reasonableness and provide written approval to the FPM**.** The approval shall be in the form of a MFR. Any change resulting in a modification to the floodproofing agreement must be approved by the FPM in writing. If the change does not result in an increase or reduction of the authorized amount, the floodproofing agreement will not be modified. If it becomes necessary to modify the floodproofing agreement due to an increase/decrease or significant change to the design, the team leader will initiate the request to RE for a modification to the floodproofing agreement. Documentation for the change will be included in the official structure file maintained in PD-S. Changes not resulting in a modification to the floodproofing agreement must be coordinated with the construction inspector and the FPM's representative.

24. Schedule Final Inspection/Closing - Upon notice from the homeowner that construction is complete and ready for final inspection, the team leader will schedule and coordinate the final inspection with all participants. Those participating in the final inspection are the homeowner, contractor, construction inspector, floodplain coordinator, REPO attorney, team leader and FPC.

25. Update Title - Prior to the closing, the REPO attorney will review the county records to verify that ownership of the structure has not changed and that no lienholders have been added since the initial ownership verification.

26. Final Inspection/Closing - The final inspection will consist of inspecting the floodproofed structure to assure that construction has been accomplished in accordance with the GP&S and obtaining from the contractor a certified elevation certificate documenting that the structure's first floor was elevated to the designed level. If the floodproofing construction is approved, the homeowner, construction inspector and the floodplain coordinator must sign a final inspection certification and final inspection floodplain checklist (sample documents included in Appendix IX). These documents will be provided to the FPC who, on behalf of the FPM, will provide a memorandum of completeness to the REPO representative certifying that the floodproofing construction is 100% complete and request that a check representing full payment be released to the homeowner and contractor. The certified elevation certificate must be enclosed with the memorandum of completeness (Appendix X) before payment can be made. Providing all the documents are satisfactory, the REPO attorney will release the payment check to the homeowner and the contractor. Prior to the release of the check, the homeowner and the contractor will complete ENG Form 1566, U.S. Army - Corps of Engineers Payment and Closing Sheet and Receipt for United States Treasury Check. This form is maintained in the official RE file for the structure. A copy of the executed form is provided to PD-S for the official structure file. Copies are also provided to the homeowner and the contractor.

27. Floodroofing Agreement Recorded - As soon as possible after completion of the Final Inspection/Closing, RE will record the floodproofing agreement and certified elevation certificate in the county records.

28. Turn Over Functional Portion of Project to Local Sponsor - In accordance with referenced PCA's, each structure floodproofed is considered a functional portion of the project. As such, the team leader will prepare a letter enclosing the recorded floodproofing agreement and elevation certificate for the District Engineer's signature officially turning that structure over to the Local Sponsor for operation and maintenance. The Local Sponsor is responsible for enforcing the restrictions placed on the property by the floodproofing agreement.

29. Notification of Completion - Once a floodproofed structure has been turned over to the Local Sponsor the FPC will advise the appropriate Project Manager of the final floodproofing construction cost (exclusive of the E&D/S&A) for that structure. The appropriate Project Manager will notify the local sponsor of the final costs in accordance with applicable PCA's and MOA's for that particular project.

JOHNSON CREEK
ARLINGTON, TEXAS

PROBLEM DESCRIPTION

Flooding causes extensive property damage, threatens the life, health, and safety of residents, and adversely affects the environment of the stream and the overall esthetics of the community. Since 1960, the City of Arlington has experienced tremendous growth. The increase in Arlington's population for the period, 1960 to 1988, has been more than fivefold. This kind of development in the Johnson Creek watershed has substantially increased the watershed's potential for rainfall runoff events to overburden the flow capacity of Johnson Creek. As a result, many structures that are presently subject to flood damages from Johnson Creek may have been safe several years ago. The City of Arlington began participating in the Regular Phase of the Nation Flood Insurance Program in December 1971.

There have been numerous instances of flooding along Johnson Creek. Damaging floods have occurred in 1949, 1957, 1962, 1964, 1965, 1966, 1968, 1971, 1974, 1977, 1979, 1981, 1989, and 1990. Flood durations were witnessed to be short, and water surfaces have been noted to rise very quickly, less than 3 hours.

SOCIAL AND ECONOMIC ANALYSIS

Economic Reaches

The study area is found along Johnson Creek in central Arlington. The initial area of investigation can be defined as that portion of Johnson Creek, within the city limits, between Avenue J, just north of Interstate Highway 30 (H-30) downstream and Mayfield Road upstream. The study area was subdivided into seven reaches based on hydrological conditions and concentrations of damageable properties. The reach boundaries are defined in Table 1.

Table 1
Study Area Reach Boundaries

Reach	Description
1	Avenue J to Randol Mill Rd
2	Randol Mill to Railroad Bridge
3	Railroad Bridge to Ruth St
4	Ruth St to Collins St
5	Collins St to Park Row St
6	Park Row St to Pioneer Pkwy
7	Pioneer Pkwy to Mayfield Rd

A total of 474 structures were identified within the 100-year flood boundary, of which about 65 percent were located between Collins Street and Park Row Boulevard. The total flood plain investment within the 100-year flood boundary is valued at over $63.3 million based on December 1997 prices and level of development.

About 63 percent of the structures, representing about 37 percent of the value of flood plain investment, are single-family residential. These are nearly all one-story detached residences, with an average structure value of about $77,000. Commercial and industrial properties represent 15 percent of the total number of structures and 40 percent of the total flood plain investment value. These businesses are concentrated in reaches 1, 2, and 3. The 10 public structures identified account for 3 percent of the flood plain investment value.

Under without-project conditions damages begin at the 2-year flood discharge in reaches 2, 4, and 5. A 10-year flood event could produce damages totaling $4.2 million. The 25-year flood discharge could produce damages that approach $6.2 million. The 100-year flood event could produce losses totaling nearly $10.4 million. A significant increase in loss occurs with the 500-year flood event that could produce about $16.1 million in damage. This would represent a loss of about 25 percent of the flood plain investment. It is estimated that a 1000-year flood event could cause direct structure and content damage that exceeds $21.0 million based on December 1997 prices. A flood event of this magnitude would destroy about 33 percent of the total investment in the study area.

The total expected annual flood losses in the study area were estimated at nearly $1.4 million, based on December 1997 prices.

PLAN FORMULATION

The planning objectives for this study are:

- Reduce flood damages, provide better health and safety measures, reduce emergency services, reduce potential for loss of life due to high velocity flows, reduce isolations caused by flood waters, reduce overtopping of bridges and roads along Johnson Creek, and reduce the loss of jobs and/or wages caused by flooding from Johnson Creek, within the city of Arlington.

- Preserve, protect, and restore environmental and aesthetically pleasing areas and maintain, as much as possible, the existing vegetation and wildlife habitat along the creek.

- Preserve and/or protect historically and culturally significant areas.

The following constraints were taken into account:

- Flood control projects, which solve problems in one area but compound them in others, should be avoided.

- Total benefits must exceed total costs for a plan to be implemented with the Corps of Engineers as a participant, unless a specific exception is granted to allow such participation.

INITIAL SCREENING OF ALTERNATIVES

An extensive number of non-structural and structural flood damage reduction alternatives were investigated for the Johnson Creek watershed. Structural measures considered were small detention lakes, channel modifications, diversions, levees, and floodwalls. Non-structural measures investigated included revision of flood plain management ordinances, relocation of structures, flood plain evacuation, flood plain acquisition by easement or fee, and flood proofing.

INVESTIGATED STRUCTURAL ALTERNATIVES

The structural plan recommended consisted of concrete-and gabion-lined channels within three of the current study reaches. In Reach 3, the channel improvement would extend a distance of 950 feet from the railroad bridge to 400 feet north of Abram Street. Between the bridge and Abram Street the design would include a concrete-lined channel. The improvement located 400 feet south of Abram Street would consist of a gabion-lined channel section. The improvement in reach 5 would require a gabion-lined channel section extending 5,600 feet from 400 feet north of Mitchell Street to Park Row Drive upstream. The reach 7 segment, a fully lined concrete channel, would extend a distance of 800 feet between Pioneer Parkway and Arkansas Lane. Bottom width of 20 feet, 30 feet, and 40 feet were analyzed.

The 20-foot bottom width (BW) channel would yield approximately $880,100 in total annual flood control benefits, and would reduce by 84 the number of structures in the 100-year flood plain. The 30-foot BW channel and the 40-foot BW channel would provide total annual flood control benefits of $1,013,100 and $1,024,200, while reducing the number of structures in the 100-year flood plain by 112 and 122, respectively. Table 2 provides a comparative economic analysis of the structural alternative.

TABLE 2
Economic Analysis of
Investigated Structural Alternatives

	20'-BW	30'-BW	40'-BW
INVESTMENT			
Estimated First Cost	**$9,262,300**	**$10,868,100**	**$12,534,500**
Annual Interest Rate	**0.0713**	**0.0713**	**0.0713**
Project Life (years)	**50**	**50**	**50**
Construction Period (months)	**18**	**18**	**18**
Compound Interest Factor	**18.93786**	**18.93786**	**18.93786**
Capital Recovery Factor	**0.0736071**	**0.0736071**	**0.0736071**
Interest During Construction	**$494,989**	**$580,806**	**$669,861**
Investment Cost	**$9,757,300**	**$11,448,900**	**$13,204,400**
ANNUAL CHARGES			
Interest	**$695,205**	**$815,734**	**$940,810**
Amortization	**$22,999**	**$26,986**	**$31,124**
Operational/Maintenance ($/years)	**$40,000**	**$40,000**	**$40,000**
Replacements	**$0**	**$0**	**$0**
TOTAL ANNUAL CHARGES	**$758,200**	**$882,700**	**$1,011,900**
ANNUAL BENEFITS			
Flood Reduction Benefits	**$880,100**	**$1,013,100**	**$1,024,200**
TOTAL BENEFITS	**$880,100**	**$1,013,100**	**$1,024,200**
NET BENEFITS	**$121,900**	**$130,400**	**$12,300**
BENEFIT-TO-COST RATIO	**1.16**	**1.15**	**1.01**

Investigated Non-Structural Alternatives

No Action Plan. The fundamental alternative to any flood control plan is the no action plan. Adoption of this alternative implies acceptance of the costs and adverse effects of continued flooding. For the city of Arlington, these estimated costs equate to approximately $1.8 million annually. In addition, the residents would continue to suffer from the social and economic stresses associated with repetitive flooding and the potential for loss of life. Although citizens with flood insurance would be partially compensated for future damages, these damages would nonetheless continue to occur and Federal funds would continue to be expended in the flood insurance program and in federal emergency flood assistance and relief. The no action plan would be recommended only when no other solutions are feasible or when environmental damage would be irreparable.

Flood Plain Management

Flood plain management is an effective means to control future development of the flood plain, and insure that existing flood problems do not worsen; however, current-flooding problems would not be eliminated with these measures. Since the City of Arlington is participating in the Flood Insurance Program and has enacted flood plain land use restrictions, no further evaluation of this alternative was considered.

Flood Warning

Flood forecasting and temporary evacuation involves the determination of imminent flooding, implementation of a plan to warn the public, and organization of assistance in the evacuation of persons and some personal property. Notification of impending flooding can be accomplished by radio, siren, and individual notification or by elaborate remote sensor devices. Some type of flood warning and emergency evacuation effort should be a part of any flood control plan. These measures normally serve to reduce the hazards to life and damage to portable personal property. Due to the short warning time on Johnson Creek (maximum of two to three hours), a flood forecasting alternative would not represent a viable complete solution to the existing flooding problems.

Flood Proofing

The single-family residential structures are usually one story frame with brick veneer, have no basements, and are constructed on at-grade reinforced concrete slab foundations. Water and sewer lines are located under the slab and often within the slab itself. The residences have several (usually three) standard door openings, as well as wide sliding door openings. The residences typically have a two-car garage built into the structure and have constructed roofs where the bearing load is distributed throughout both interior and exterior walls.

Consideration was given to sealing of structures by permanent and temporary means. There are many devices and construction procedures available for this type of flood proofing. Measures differ with each structure and the flood situation. Important considerations include the ability of openings to be closed, the watertightness of exterior walls, structural adequacy of the building, and in the case of temporary measures, flood warning time and reliability of installation.

There are many limitations and potential hazards involved in keeping water out of the type of residential structures located along Johnson Creek. When water is prevented from entering these structures, the outside walls become subject to lateral hydrostatic pressures, resulting in bending or shear forces within the walls, which can cause structural failure. Floors would also be subject to uplift forces which could cause buckling or flotation. The velocity of the flood water would be greater than five feet per second, creating great dynamic forces against the structures. The houses in the area are not designed to withstand these forces. For the types of home found in the Johnson Creek flood plain, water depths exceeding two to three feet above the first floor would cause significant structural damage. Many of these homes would have greater than three feet of flooding for the 100-year event.

Permanent or temporary closures were not considered applicable to structures along Johnson Creek. Due to the structural limits placed on flood shields (not greater than two to three feet in height), protection levels would not be acceptable. There is a high probability of the measures failing due to improper placement and maintenance. The short warning time on Johnson Creek also contributes to non-applicability. Due to the high probability of structural failure, flood-proofing measures to keep water out of structures along Johnson Creek were found to be infeasible.

Raising of single family residential structures was also considered for the 10-year flood zone. Many of the homes to be raised are of ranch-type construction with a U- or L-shaped floor plan, making raising extremely difficult and costly. The slabs, poured on grade, have uneven undersurfaces. Raising the slabs themselves would require the placement of beams under the slab. Points of high pressure would develop, and the slab would probably crack, causing further damage to the structure. An alternative raising technique would consist of removing the brick veneer, cross bracing the interior of the home, lifting it from the slab, and severing all utility connections. Fill material would be placed on the lot and a new foundation, with utility connections, would be constructed. The home would then be returned to the original lot. In both techniques, some portions of the structure would be detached and raised separately. Typical detached portions would be a garage or a single room built out from the main portion of the house. A considerable amount of movement and temporary storage space for these homes would be required. This movement and storage would be needed so that higher level permanent foundations could be built on the owners' properties. Since the structures are built with the bearing load distributed throughout the structure, raising the structure and movement would almost surely cause a large amount of structural damage to interior and exterior walls. It is probable that the raising and movement would damage the home to an irreparable state.

The raising of a large amount of residential structures would take a considerable amount of time. Temporary relocation of residents would be required, resulting in additional costs and adverse social and community impacts. If raising of individual structures in place were implemented; an emergency evacuation plan would be required since most of the residents would be isolated during flood conditions. It was therefore concluded that raising of structures would be a very undesirable flood control solution for the Johnson Creek flood plain. This solution was not feasible because raising structures built with slab on-grade would be impractical, and significant dangers would continue to exist when floods occur. This measure may in fact increase the threat to life and safety if residents were to become isolated by surrounding flood waters.

Permanent Evacuation

Acquisition and removal of structures within the 2, 5, 10, and 25-year flood plains were analyzed for each individual reach within the study area and for the watershed aggregately.

Benefit Methodology. As stated in Engineering Regulation (ER) 1105-2-100, and in the Institute of Water Resources (IWR) Report 88-R-2, benefits for the removal of individual structures from the flood plain are limited to the sum of:

annualized residual value of the vacated land, or average annual recreation benefits for the land

plus:

reduction in annual flood insurance subsidy:

agency cost:

average annual damages to the structure and its contents

plus:

agent fee (at 15 percent of the estimated premium), and other administrative costs (at $131 per policy)

minus:

policy holder's cost:

estimated annual insurance premium (at $0.55 per $100 of structure value for the first $45,000 and $0.17 per $100 thereafter, plus $0.65 per $100 of contents value for the first $15,000 and $0.30 per $100 thereafter),

annual deductible ($500 each for structure and contents per flood occurrence, times the probability of a flood in a typical year), and

annual uninsured losses (5 percent of the structure value per flood occurrence, times the probability of a flood in a typical year)

plus:

average annual public damages prevented (that is, damages to communications and public utilities facilities, and costs for flood fighting and public relief) based on actual FEMA claims.

The inclusion of recreation benefits would be based on an evaluation of the spacial proximity of the structures removed, and the suitability of the neighborhood for land use changes.

Benefits Analysis - Acquisition and Removal Plans. Table 3 presents the economic analyses for acquisition and removal of structures in each flood event investigated, within each of the reaches indicated. The benefits presented in this table reflect only the direct benefits of the acquisition, and do not include potential recreation benefits. The finished floor elevations of structures in reach 1 are of sufficient heights that flood damages within this reach would not be incurred until a 25-year flood event is experienced. In addition, reach 3 consists entirely of commercial structures, for which the City of Arlington has expressed a desire to refrain from purchasing at this time. For these reasons, reaches 1 and 3 were excluded from further non-structural flood damage reduction investigations.

The results shown in table 3 were used to preliminarily identify those reaches for which the inclusion of recreation benefits could potentially yield feasible plans. A benefit-cost ratio of 0.6 or greater was established as the, benchmark to determine whether the addition of recreation features should be investigated.

As shown, the evaluation of reaches 2 and 7 identified a small number of structures located in the targeted exceedence events. In reach 2, the estimated first cost to acquire and remove the two structures identified was approximately $92,300. Total annual benefits of only $1,773, and a BCR of 0.24, was calculated for this reach. Eligible structures in reach 7 were identified in the 10-and 25-year flood plain; however, the BCR for each zone would be well below 0.6, thereby eliminating the need to investigate recreation possibilities. Therefore, acquisition of even the most frequent flood events in reaches 2 and 7 was deemed infeasible.

Acquisition of six structures identified in the 5-year flood plain in reach 4 would yield a BCR of 0.65, indicating that recreation features might be beneficial. However, the scattered locations of the structures prohibited development of a cohesive recreation plan. The BCR for other exceedence events in reach 4 were insufficient to prompt further analysis. Therefore, reach 4 was excluded from further flood damage reduction investigation.

The evaluation of reach 5 yielded the most favorable results. As shown, the BCR for each targeted exceedence event was above the 0.6 benchmark. Furthermore, the linear configuration and density of the identified structures yielded adequate space for the development of a recreation plan, which would be compatible with the city's master recreation objectives.

The investigation of reach 6 showed acquisition of two structures within the 5-year flood plain would have a BCR of 1.03, and would be marginally feasible even without inclusion of recreation benefits. All other zones would be infeasible, however, with BCR values well below 0.6.

TABLE 3
Economic Analysis of Non-Structural Plans-Without Recreation
(December 1997 prices, 7.125%, 50-year period of analysis)

		FLOOD EVENT			
		2-year	5-year	10-year	25-year
Reach 2	First Cost	$92,300	$92,300	$92,300	$92,300
	Annual Cost	$7,312	$7,312	$7,312	$7,312
	Buy-out Benefits	$1,773	$1,773	$1,773	$1,773
	Net Benefits	($5,539)	($5,539)	($5,539)	($5,539)
	Benefit-Cost Ratio	0.24	0.24	0.24	0.24
	No. of Structures Removed	2	2	2	2
Reach 4	First Cost	$0	$241,200	$418,700	$1,720,100
	Annual Cost	$0	$19,263	$33,705	$136,070
	Buy-out Benefits	$0	$12,481	$16,147	$28,330
	Net Benefits	$0	($6,782)	($17,557)	($107,740)
	Benefit-Cost Ratio	N/A	0.65	0.48	0.21
	No. of Structures Removed	0	6	9	25
Reach 5	First Cost	$5,738,500	$10,024,800	$11,690,500	$12,804,300
	Annual Cost	$456,568	$798,731	$931,490	$1,020,455
	Buy-out Benefits	$429,222	$611,033	$633,243	$641,036
	Net Benefits	($27,345)	($187,697)	($298,247)	($379,420)
	Benefit-Cost Ratio	0.94	0.77	0.68	0.63
	No. of Structures Removed	58	107	125	138
Reach 6	First Cost	$0	$271,900	$1,150,900	$1,531,700
	Annual Cost	$0	$20,762	$88,189	$117,506
	Buy-out Benefits	$0	$21,452	$29,924	$29,924
	Net Benefits	$0	$690	($58,265)	($87,582)
	Benefit-Cost Ratio	N/A	1.03	0.34	0.25
	No. of Structures Removed	0	2	10	14
Reach 7	First Cost	$0	$0	$525,600	$2,102,500
	Annual Cost	$0	$0	$39,423	$159,052
	Buy-out Benefits	$0	$0	$7,901	$14,219
	Net Benefits	$0	$0	($31,521)	($144,833)
	Benefit-Cost Ratio	N/A	N/A	0.20	0.09
	No. of Structures Removed	0	0	2	8
All Reaches	First Cost	$5,830,800	$10,630,200	$13,878,000	$18,250,900
	Annual Cost	$464,125	$847,674	$1,124,765	$1,477,647
	Buy-out Benefits	$430,995	$646,739	$688,988	$715,282
	Net Benefits	($33,129)	($200,935)	($435,777)	($762,365)
	Benefit-Cost Ratio	0.93	0.76	0.61	0.48
	No. of Structures Removed	60	117	148	187

In summary, the results of the preliminary analyses for non-structural acquisition and removal of residential structures within the study area resulted in the determination that such measures would be infeasible for all zones in reaches 1, 2, 3, 4, and 7, and for all but the 5-year flood in reach 6. It was also determined, however, that further investigation was warranted for

the addition of recreation features, and benefits, in all zones in reach 5 and in the 5-year flood zone in reach 6.

Benefit Analysis - Recreation Plans. Recreation plans for each of the potentially feasible flood zones were developed to effectively utilize the spatial configuration, once the identified structures were removed. Due to the isolated nature of the structures in reach 6, no recreation was proposed in that area. Recreation features were developed for each of the investigated zones in reach 5 to enhance the aesthetics of the area, to help satisfy the identified recreational needs and objectives of the region, and to determine whether an overall acquisition/recreation plan could be identified to meet the established planning goals. The economically beneficial features considered included hike/bike trails, picnic sites, and pavilions. In addition, facilities necessary for access and serviceability of the park, including signage, parking, and footbridges were included.

Table 4 presents the recreation features and annual benefits claimed for each of the flood zones in reach 5. As shown, the annual benefits range from $366,474 for the 2-year flood to $697,030 for the 10 and 25-year floods. The economic benefits for recreation facilities constructed on the evacuation lands which could be claimed toward the project, however, were limited to amounts equal to the flood damage reduction benefits in reach 5.

Summary

Table 5 presents a comparative analysis of the alternatives investigated in the initial screening process. As shown, each structural plan and each non-structural acquisition/recreation plan would be economically feasible. The optimum structural plan, which would consist of 30-foot bottom width segmented channelization, would yield net annual flood damage reduction benefits of approximately $130,400, and a BCR of 1.15. Comparatively, the preliminary optimum non-structural plan, which would include acquisition and removal of structures in the 2-year flood zone in reach 5, with compatible recreation features, would provide net annual benefits of approximately $290,200, and a BCR of 1.57.

Due to the results of these preliminary analyses, and because of the sponsor's rejection of recently proposed structural alternatives within the Johnson Creek watershed so that a more environmentally sensitive plan could be pursued, non-structural flood damage reduction measures were reassessed in more detail, using a risk-based analysis approach, to identify the NED Plan.

TABLE 4
Recreation Features and Benefits
Evacuation Lands - Reach 5
(December 1997 prices, 7.125%, 50-year period of analysis)

Flood Event	Feature	Amount	Annual Benefits
2-year	Hike/Bike Trail (LF)	5,982	$295,284
	Uncovered Picnic Sites	10	$71,190
	Parking Spaces	21	$0
	Footbridges	1	$0
		Total Benefits	$366,474
5-year	Hike/Bike Trail (LF)	7,315	$427,390
	Uncovered Picnic Sites	10	$84,263
	Covered Picnic Sites	3	$25,279
	Parking Spaces	21	
	Footbridges	2	
		Total Benefits	$536,931
10 and 25-year	Hike/Bike Trail (LF)	7,315	$427,390
	Uncovered Picnic Sites	20	$176,951
	Covered Picnic Sites	10	$92,689
	Pavilion	1	
	Parking Spaces	40	
	Footbridges	3	
		Total Benefits	$697,030

FINAL ARRAY OF ALTERNATIVES

This section presents the final array of flood damage reduction alternatives investigated in the determination of the NED Plan. In addition, environmental restoration and associated recreation opportunities, objectives, and plan formulation activities are documented herein.

For this phase of the planning process, a risk-based analysis was used to calculate the benefits derived from implementation of the various alternatives investigated. This analysis was accomplished using the Hydrologic Engineering Center-Flood Damage Assessment (HEC-FDA) program

TABLE 5
Preliminary Economic Analysis
Of Investigated Alternatives
(December 1997 prices, 7.125%, 50-year period of analysis)

	Segmented Channel Plans			Non-Structural Alternatives - With Recreation			
	20' BW	30' BW	40' BW	2-year Reach 5	5-year Reach 5&6	10-year Reach 5 5-year Reach 6	25-year Reach 5 5-year Reach 6
Investment							
Estimated First Cost	$9,262,300	$10,868,100	$12,534,500	$6,294,600	$10,979,500	$12,861,600	$13,975,400
Construction Period (Months)	18	18	18	18	24	24	24
Interest During Construction	$494,989	$580,806	$669,861	$336,392	$791,600	$927,251	$1,007,549
Investment Cost	$9,757,300	$11,448,900	$13,204,400	$6,631,000	$11,771,100	$13,788,900	$14,982,900
ANNUAL CHARGES							
Interest	$695,205	$815,734	$940,810	$472,458	$838,688	$982,456	$1,067,535
Amortization	$22,999	$26,986	$31,124	$15,630	$27,746	$32,502	$35,316
Operation/Maintenance	$40,000	$40,000	$40,000	$17,400	$54,500	$63,500	$70,000
TOTAL ANNUAL CHARGES	$758,200	$882,700	$1,011,900	$505,500	$920,900	$1,078,500	$1,172,900
ANNUAL BENEFITS							
Flood Damage Reduction Benefits	$880,100	$1,013,100	$1,024,200	$429,200	$632,500	$654,700	$662,500
Recreation Benefits	$0	$0	$0	$366,500	$536,900	$633,300	$641,100
TOTAL BENEFITS	$880,100	$1,013,100	$1,024,200	$795,700	$1,169,400	$1,288,000	$1,303,600
NET BENEFITS	$121,900	$130,400	$12,300	$290,200	$248,500	$209,500	$130,800
BENEFIT-COST RATIO	1.16	1.15	1.01	1.57	1.35	1.19	1.11
No. of Structures Removed	84	112	122	58	109	127	140

FLOOD DAMAGE REDUCTION

The flood damage reduction alternatives brought forward from the initial screening process included acquisition and removal of structures in the 2, 5, 10, and 25-year flood zones in reach 5, and in the 5-year flood zone in reach 6. In conjunction with these acquisition's, more detailed recreation plans were developed, and these features were added in a manner that would maximize net benefits without generating excess user benefits which could not be claimed toward the project. Table 6 presents the features of the revised recreation plans added to each of the investigated acquisition and removal plans.

Recreation Benefits

Benefits for the recreation plan developed for the buy-out were derived using the unit day value method. This method of benefit calculation was selected based on the criteria set forth in ER 1105-2-100, paragraph 6-90d, dated December 1990. Based on application of the required regional unit day value model, annual visits are expected to approach 750,000. Further, it is anticipated that costs associated with recreation features will remain at or below 25 percent of the total project costs. Relying on the professional judgement of recreation planners, each recreation plan was scored based on a numerical assessment of the number and type of activities, accessability, aesthetics, and competition with existing facilities. Three plans were designed based on the amount and location of the project land under the various plans. A score of 50 points was assessed for recreation plans designed for the 5, 10, and 25-year floods buy-out zones. The plan designed for the 2-year flood zone was assessed a score of 40 points. Recreation plans designed for restoration lands were assessed a score of 30 points. Planning Guidance Memorandum 97-3 was applied to the assessed scores to arrive at dollar values. Based on quantifiable features, a score of 50 points converts to $5.35 per visitor day, 40 points converts to $4.72 per visitor day, and a score of 30 points converts to $3.78 per visitor day. Since the participation rate in the Arlington-Fort Worth area for multi-purpose trails picnic sites and pavilions exceed the facility capacity, it was assumed that participation equals capacity and a value of one was applied. Trails would generate 57,662 visitor days per mile or 10.92 visitor days per linear foot. Uncovered picnic sites and pavilions would provide 1,575 visitor days per site.

TABLE 6
Revised Recreation Features and Benefits
Reach 5 - Evacuation Lands
(December 1997 prices, 7.125%, 50-year period of analysis)

Feature	2-year Flood		5-year Flood		10-year Flood		25-year Flood	
	Amt.	Annual Benefits	Amt.	Annual Benefits	Amt.	Annual Benefits	Amt.	Annual Benefits
Trail (LF)	5,280	$308,492	6,634	$387,601	7,065	$412,783	7,677	$448,540
Picnic Sites	20	$168,525	35	$294,919	35	$294,919	35	$294,919
Pavilion	1	$8,426	1	$8,426	1	$8,426	1	$8,426
Parking Spaces	36	0	8	$0	8	$0	48	$0
Foot Bridges	3	$0	3	$0	3	$0	3	$0
Total Benefits		$485,443	$690,946		$716,128		$726,586	

The following sections present the economic analyses for each of the investigated alternatives, along with the expected impacts to environmental and cultural resources, and possible regulated materials, which may be encountered.

Permanent Evacuation: 2-year Flood Zone - Reach 5

The proposed alternative would involve the acquisition and removal of 58 structures. The project first cost of this alternative was estimated at $6,470,800. The annual cost would be approximately $539,635, and would include an estimated $29,000 in annual operation and maintenance costs. The total expected annual benefits would be approximately $960,836, which would include $480,418 in recreation benefits. The BCR for this alternative would be 1.78 and the annual net benefits would be $421,201. The economic analyses of this plan and all other plans investigated in the final array of alternatives are presented in table 7.

TABLE 7
Economic Analyses of Non-Structural Alternatives
(December 1997 prices, 7.125%, 50-year period of analysis)

	Non-Structural Alternatives - With Recreation			
	2-year Reach 5	5-year Reach 5&6	10-year Reach 5 5-year Reach 6	25-year Reach 5 5-year Reach 6
INVESTMENT				
Estimated First Cost	**$6,470,800**	**$11,120,500**	**$12,816,900**	**$14,007,700**
Construction Period (Mos.)	**24**	**24**	**24**	**24**
Interest During Construction	**$466,500**	**$792,354**	**$928,894**	**$1,009,878**
Investment Cost	**$7,151,621**	**$11,922,227**	**$13,740,928**	**$15,017,578**
ANNUAL CHARGES				
Interest	**$494,283**	**$849,459**	**$979,041**	**$1,070,002**
Amortization	**$16,352**	**$28,102**	**$32,389**	**$35,398**
Operation/Maintenance	**$29,000**	**$54,500**	**$63,500**	**$70,000**
TOTAL ANNUAL Charges	**$539,635**	**$932,061**	**$1,074,930**	**$1,175,400**
ANNUAL BENEFITS				
Buy-out Benefits	**$480,418**	**$731,804**	**$749,025**	**$791,041**
Recreation Benefits	**$480,418**	**$690,946**	**$716,128**	**$751,885**
TOTAL BENEFITS	**$960,836**	**$1,422,750**	**$1,465,153**	**$1,542,926**
NET BENEFITS	**$421,201**	**$490,690**	**$390,223**	**$367,526**
BENEFIT-COST RATIO	**1.78**	**1.54**	**1.37**	**1.31**
No. of Structures Removed	**58**	**109**	**127**	**140**

Permanent Evacuation 5-year Flood Zone - Reach 5 and 6

The proposed alternative would involve the acquisition and removal of 109 structures. The project first cost of this alternative was estimated at $11,120,500. The annual cost would be approximately $932,061, and would include an estimated $54,500 in annual operation and maintenance costs. The total expected annual benefits would be approximately $1,422,750, which would include $690,946 in recreation benefits. The BCR for this alternative would be 1.54 and the annual net benefits would be $490,690. The economic analyses of this plan and all other plans investigated in the final array of alternatives are presented in Table 7.

Permanent Evacuation 10-year Flood Zone - Reach 5 and 5-year Flood Zone - Reach 6

The proposed alternative would involve the acquisition and removal of 127 structures. The project first cost of this alternative was estimated at $12,816,900. The annual cost would be approximately $1,074,930, and would include an estimated $63,500 in annual operation and maintenance costs. The total expected annual benefits would be approximately $1,465,153, which would include $716,128 in recreation benefits. The BCR for this alternative would be 1.37 and the annual net benefits would be $390,223. The economic analyses of this plan and all other plans investigated in the final array of alternatives are presented in table 7.

Permanent Evacuation 25-year Flood Zone - Reach 5 and 5-year Flood zone - Reach 6

The proposed alternative would involve the acquisition and removal of 140 structures. The project first cost of this alternative was estimated at $14,007,700. The annual cost would be approximately $1,175,400, and would include an estimated $70,000 in annual operation and maintenance costs. The total expected annual benefits would be approximately $1,542,926, which would include $751,885 in recreation benefits. The BCR for this alternative would be 1.31 and the annual net benefits would be $367,526. The economic analyses of this plan and all other plans investigated in the final array of alternatives are presented in table 7.

SUMMARY

The evaluation of various non-structural flood damage reduction alternatives resulted in the determination that acquisition and removal of structures in the 5-year flood zone in reaches 5 and 6, with compatible recreation features, would yield the greatest net annual economic benefits, as shown in table 7. This alternative was, therefore, deemed to constitute the flood damage reduction component of the NED Plan.

This plan would entail the acquisition and removal of 107 residential structures in reach 5, and two structures within reach 6. Recreation facilities added in conjunction with this buyout plan would consist of 6,634 linear feet of concrete trail, 35 uncovered picnic sites, one covered pavilion, three footbridges, and four access points. The access areas would have a combined capacity of 48 parking spaces, and would each include an information kiosk, security lighting, and a drinking fountain.

The total first cost of this plan was estimated at $11,120,500. The plan would yield annual net benefits of $490,690, and a BCR of 1.54.

No adverse impacts to environmental or cultural resources are expected from implementation of this plan.

RECOMMENDED PLAN

FLOOD DAMAGE REDUCTION

The Recommended Plan would consist of the acquisition and removal of a total of 109 residential structures in the 5-year flood zone, within reaches 5 and 6 of the watershed. Of these 109 structures, 107 are located in reach 5, between Park Row Drive and Collins Street. The two structures identified for acquisition and removal in reach 6 are located on Mitchell Street.

Permanent closure several streets, or portions thereof, would be recommended in conjunction with this plan. The affected streets would include Dover Lane, Wilkinson, Ray, Ruby, and Turtle Creek.

The total cost of acquisition, demolition and disposal of these structures was estimated at approximately $10,808,800. Additional relocation assistance costs of $1,137,600 would be required; therefore, total flood damage reduction costs would be approximately $11,946,400.

ENVIRONMENTAL RESTORATION

An incremental analysis was conducted to identify the most effective environmental restoration measures which could be implemented to best meet the environmental needs identified within the creek corridor.

The Recommended Plan would include acquisition of approximately 195 acres of currently undeveloped areas within the corridor, of which 94 acres would be existing grass/shrub lands and 101 acres would be existing forested areas.

The measures identified as most effective for conversion of grass/shrub land would involve the planting of 5 one-inch caliper containerized trees, 5 one-gallon shrubs and 200 seedlings per acre. Improvement of existing forested areas would be accomplished by planting 5 one-inch caliper containerized trees and 5 one-gallon shrubs per acre. Additional forest management techniques would be required, such as girdling trees or limbs to create snags and cavities and selective thinning of the canopy or understory vegetation, in forested tracts where application of these techniques is needed to improve the quality of the habitat for wildlife.

The first cost of the environmental measures, including real estate acquisition, indirect contractor costs, and contingencies would total approximately $2,564,000. These measures would yield gains of 149.66 AAHU over the no action alternative.

RECREATION

Recreation on Evacuation Lands

Since the economic benefits derived from recreation features are considered an integral part of an overall non-structural flood damage reduction plan, these features were developed to maximize net benefits without generating excess user benefits which could not be claimed toward the project. Policy Guidelines state that recreation benefits cannot comprise more than 50 percent of the total flood damage reduction benefits for a non-structural plan.

The recreation features, which would be added to the evacuation lands for the Recommended Plan, would include 6,634 linear feet of concrete trail, configured to allow access from four different areas. A life cycle cost analysis was conducted which determined that concrete would be the most cost effective material to use in the construction of this trail.

Two of the access areas would be constructed on lands currently occupied by structures, and would each include 12 parking spaces. The other two access areas would utilize portions of Ruby Street and Turtle Creek Drive identified for closure, but would increase the asphalt-paved area to accommodate a total of 12 parking spaces each. Informational kiosks, security lighting and a drinking fountain would be provided at each of these access points. Three footbridges, each measuring 1 0-feet wide and 120-feet long, would span the creek within reach 5, and would support pedestrian, bicycle, and maintenance vehicle traffic. A total of 35 uncovered picnic sites would be located within reach 5, and a 30-foot by 60-foot pavilion would be located in the evacuation area north of Mitchell Street, and adjacent to Collins Street.

The total first cost of these recreational features, including engineering, design and construction management would be approximately $832,700. Annual net recreation benefits of approximately $595,900 would be added to the net flood damage reduction benefits derived from the acquisition and removal plan identified previously, thereby creating a cumulative net flood damage reduction benefit of $449,600.

Recreation on Environmental Restoration Lands

Due to the limits placed on the costs of recreational facilities on restoration lands, the only such recreation features in the Recommended Plan would include 1,406 linear feet of concrete trail, linking the main acquisition area in reach 5 to the evacuation area containing the proposed pavilion, described above. The total first cost of these recreational features would be approximately $63,600, with annual charges of $9,800. Annual recreation benefits of $58,100 would be obtained yielding annual net benefits of approximately $48,300, and a BCR of 5.95.

ECONOMIC SUMMARY

Table 8 presents the economic summary for the Recommended Plan, including flood control and recreation. Environmental restoration benefits are not included in this table, since the outputs of an environmental restoration plan are non-monetary in nature. Likewise, the costs for environmental restoration features are shown as financial costs, but are excluded from the economic costs.

As shown, the total economic cost of the Recommended Plan would be approximately $11,705,000. The plan would have annual costs of $983,400, total annual economic benefits of $1,480,800, net annual benefits of $497,400, and a BCR of 1.51. The environmental restoration component of the Recommended Plan would have an estimated total first cost of $2,564,000, and would yield an increase of 149.66 average annual habitat units (AAHU) over the no action alternative.

PUBLIC INVOLVEMENT

This Feasibility Study focused on the development of an economically feasible, environmentally acceptable, publicly supportable solution to the flooding problems within the Johnson Creek, Arlington area. Numerous meetings and conversations have been held with the various entities and interested citizens to share the latest possible information and to focus this study toward investigating the most viable alternatives. In addition, various public workshops/meetings were held in the study area for the citizens to give input into the problems and possible solutions, as stipulated by Public Law 99-662 and Public Law 104-303.

During the life of the Feasibility Report/Environmental Assessment preparation (1996 through 1998), numerous meetings with concerned individuals, groups, and affected property owners have been held to answer questions and receive feedback. Additionally, numerous letters and other correspondence have been transmitted to organizations and individuals to answer their questions and receive their feedback on the proposed project.

TABLE 8
Economic Summary of the Recommended Plan
(December 1997 prices, 7.125%, 50-year period of analysis)

Project Costs	Financial Costs	Economic Costs
Lands & Damages (Flood Damage Reduction	$9,863,700	$9,863,700
Lands & Damages (Environmental Restoration)	$2,312,800	$0
Relocation Assistance	$1,137,600	$0
Fish & Wildlife Facilities (Environmental Restoration)	$210,800	$0
Construction (Flood Control)	$793,200	$793,200
Construction (Recreation - Flood Control Lands)	$698,800	$698,800
Construction (Recreation - Restoration Lands)	$53,300	$53,300
Engineering & Design (Flood Control)	$116,300	$116,300
Engineering & Design (Environmental Restoration)	$30,900	$0
Engineering & Design (Recreation - Flood Control Lands)	$102,500	$102,500
Engineering & Design (Recreation - Restoration Lands)	$7,800	$7,800
Construction Management (Flood Control)	$35,600	$35,600
Construction Management (Environmental Restoration)	$9,500	$0
Construction Mgmt (Recreation - Flood Control Lands)	$31,300	$31,300
Construction Mgmt (Recreation - Restoration Lands)	$2,400	$2,400
Project First Cost	$15,406,500	$11,705,000
Interest During Construction		$846,800
Total Investment		$12,551,800
Annual Costs		
Interest & Amortization		$923,900
OMRR&R		$59,500
Total Annual Cost		$983,400
Expected Annual Benefits		
Acquisition/Removal Benefits		$731,800
Recreation Benefits - Flood Control Lands		$690,900
Recreation Benefits - Restoration Lands		$58,100
Total Expected Annual Benefits		$1,480,800
Net Annual Benefits		$497,400
Benefit-Cost Ratio		1.51

MISSOURI RIVER
NEAR PIERRE AND FORT PIERRE,
HUGHES AND STANLEY COUNTIES
SOUTH DAKOTA

INTRODUCTION

This project is authorized under Public Law 105-277, 112 Stat 2681 (Section 136), as amended by Section 258 of the Agricultural Risk Protection Act of 2000. The Secretary of the Army is authorized to acquire from willing sellers, such land and property in the vicinity of Pierre in Hughes County and Fort Pierre in Stanley County, South Dakota, or to flood proof or relocate such property within the project area as the Secretary determines is adversely affected by the full wintertime Oahe Power plant releases.

Sections 136, Division C, Title I and 106 Division A of Public Law 105-277 Omnibus Consolidated and Emergency Supplemental Appropriations Act, 1999, enacted October 21, 1998 (112 STAT. 2681):

a. Section 136, Division C Title I (112 STAT. 2681-598) Flood Mitigation Near Pierre, South Dakota.

(a) IN GENERAL

(1) LAND ACQUISITION. --To provide full operational capability to carry out the authorized purposes of the Missouri River Main Stem dams that are part of the Pick-Sloan Missouri River Basin Program authorized by section 9 of the Act entitled "An Act authorizing the construction of certain public works on rivers and harbors for flood control, and other purposes", approved December 22, 1944, the Secretary may acquire from willing sellers such land and property in the vicinity of Pierre, South Dakota, or floodproof or relocate such property within the project area, as the Secretary determines is adversely affected by the full wintertime Oahe power plant releases.

(2) OWNERSHIP AND USE. --Any land that is acquired under this authority shall be kept in public ownership and will be dedicated and maintained in perpetuity for a use that is compatible with any remaining flood threat.

(3) REPORT. --

(A) IN GENERAL. --The Secretary shall not obligate funds to implement this paragraph until the Secretary has completed a report addressing the criteria for selecting which properties are to be acquired, relocated or flood proofed, and a plan for implementing such measures and has made a determination that the measures are economically justified.

(B) DEADLINE. --The report shall be completed not later than 180 days after funding is made available.

(4) COORDINATION AND COOPERATION. --The report and implementation plan--

(A) shall be coordinated with the Federal Emergency Management Agency; and

(B) shall be prepared in consultation with other Federal agencies, and State and local officials, and residents.

(5) CONSIDERATIONS.--Such report should take into account information from prior and ongoing studies.

(b) AUTHORIZATION OF APPROPRIATIONS. -There is authorized to be appropriated to carry out this section $35,000,000.

b. Section 106, Division A (112 STAT. 2681-544), directed the Secretary of the Army, acting through the Chief of Engineers, to use $340,000 of the available "Construction, General" funds to initiate construction of the Pierre, South Dakota, flood mitigation project.

House Record 2559 Agricultural Risk Protection Act of 2000 Sec. 258. Flood Mitigation Near Pierre, South Dakota.

(a) REQUIREMENT- Subject to subsection (b), as soon as practicable after the date of the enactment of this Act, with respect to land and property described in the Flood Mitigation Study and Project Implementation Plan for the Missouri River near Pierre, South Dakota, prepared by the Omaha District Corps of Engineers, dated August 12, 1999, the Secretary of the Army shall--

(1) acquire the land and property from willing sellers; and

(2) (A) floodproof the land;

(B) relocate individuals located on the land;

(C) improve infrastructure on the land; or

(D) take other measures determined by the Secretary.

(b) RELEASES-

(1) IN GENERAL- The Secretary shall not proceed with full wintertime Oahe Powerplant releases until the Secretary amends the economic analysis in effect on the date of the enactment of this Act to include an assumption that the Federal Government is responsible for mitigating any existing ground water flooding to the land and property described in subsection (a).

(2) REDUCTION- To the extent the Secretary identifies benefits of mitigating any existing ground water flooding, full wintertime Oahe Powerplant releases shall be reduced consistent with the economic analysis described in paragraph (1).

(3) MINIMUM LEVEL- This subsection shall not permit Oahe Powerplant releases to be reduced below existing operational levels.

PROBLEM DESCRIPTION

The project area consists of the Missouri River just downstream of Oahe Dam near Pierre and Fort Pierre, South Dakota. Oahe Dam is located 6 miles northwest of Pierre, South Dakota. Downstream of Oahe Dam is Lake Sharpe created by Big Bend Dam approximately 80 miles downstream. Oahe Dam controls the majority of the flow into Lake Sharpe. Oahe Dam is a peaking power plant and one of the six main stem dams on the Missouri River constructed by the Corps of Engineers. Mean daily releases from Oahe range from less than 1,000 cubic feet per second (cfs) to 57,000 cfs depending on power demands and other project purposes. The principle tributary of the river between Big Bend and Oahe Dam is the Bad River.

The Missouri River channel below Oahe Dam is contained within a relatively narrow alluvial floodplain. From Oahe Dam downstream about six miles to Pierre, high, steep bluffs form the left bank of the channel. The floodplain along the right bank extends downstream to Fort Pierre at the confluence of the Bad River. Below the confluence, the floodplain exists on the left bank and the high, steep bluffs are located on the right bank. LaFramboise Island and Farm Island divide the channel for a distance of about eight miles, extending into the headwaters of the Big Bend pool.

Construction of Oahe Dam began in September 1948, and the Missouri River was diverted through its outlet works in August 1958. Power generation began in April 1962, and by 1963 the Oahe Dam was in full operation. At present, the power plant has a capability to discharge 57,000 cfs at full power plant capacity with great variations in release from hour-to-hour and day-to-day.

Seasonal release patterns reflect the restricted system releases during the winter months and higher releases needed to support Missouri River navigation during much of the remainder of the year. Reduced outflows during October and November allow the evacuation of flood storage space in the downstream Fort Randall Reservoir and the recapturing power of higher releases from the upstream reservoirs in the forthcoming winter period. The increased December releases permit the Oahe Project to serve a higher than usual proportion of the system's winter power generation while freeze-up of the Missouri River channel is occurring below Ft. Peck Dam, Montana and Garrison Dam, North Dakota which restricts releases from those projects.

Big Bend Dam impounds Lake Sharpe. Project construction was started in 1959 and closure of the embankment was made in July 1963. The first commercial power generation began in 1964. Big Bend is primarily a power-generating project, operated to meet peak load demands. High releases from Oahe Dam directly influence the pool level in Lake Sharpe, which in turn affects river stage levels in the backwater reach through Pierre and Fort Pierre. The backwater of the downstream Big Bend Reservoir extends upstream to the Oahe Dam tailwater. Consequently, Lake Sharpe influences the entire original Missouri River channel below Oahe to some extent.

Sediment deposits became noticeable shortly after the closure of Big Bend Dam in 1963. Flood events on the Bad River are the primary contributor of sediment to Lake Sharpe in the Pierre and Fort Pierre area. The sediment deposition has gradually increased water surface elevations in the Pierre and Fort Pierre area and the rise in water surface has influenced the ground water level in the area. However, existing data is insufficient to determine the extent of the ground water impacts. Although the sediment has developed as originally predicted, the increased stages due to the combination of sediment impacts and ice-affected flow conditions was not foreseen.

Minor ice affected flooding has occurred in the Pierre area in 1979, 1981, 1983, 1994 and 1997 and lasted from 1 to 10 days. This flooding has occurred when high water backed up into one of the City of Pierre storm sewers and on to low lying streets in South East Pierre and froze in sub zero temperatures.

The yearly average number of days ice conditions occurred between 1968 and 1994 was 16.7 days. Hourly discharges from Oahe have been restricted to 25,000 cfs for periods of several days in the winter during the 1990's and on one day the hourly release was restricted to 18,000 cfs. The longest period of constrained Oahe generation was from January 18 through February 8, 1996. Maximum generation limits from 400 to 550-MW were imposed during that extended event. Full Oahe power plant capability during that event was 712 MW. The most severe constraint placed on Oahe generation for a river ice related event occurred on January 10, 1997 when it was necessary to impose three consecutively lower caps on maximum generation.

Oahe Dam powerplant releases were restricted up to 70% in January 1997 from 600 MW to 160 MW during a critical peak winter demand to prevent flooding from occurring in Southeast Pierre. Due to the large discharge prior to the reduction, the large volume of water in the river between the dam and the Pierre area backed up into local storm sewers causing shallow flooding over the streets and in the low-lying area in southeast Pierre. The flooding caused access

problems to homes and froze vehicles in place on the streets. With future aggradation, overbank flooding will occur under ice conditions more frequently with less than full powerplant releases.

Current projections of future sedimentation and vegetation encroachment indicate that the open water releases will be constrained. This will reduce the summer-time dependable capacity of the plant and reduce the ability of the plant to provide peaking service. The average summertime (July and August) capacity of the plant would be reduced by about 180 MW. The average summertime plant factor would be increased from 56% to 72%.

PROJECT DESCRIPTION

The authorizing legislation identified the project boundary as that area adversely impacted by the full winter time release of Oahe Dam. However a project implemented to this level would cost in access of $200 million and would not be locally acceptable. There is currently authorized $35 million for the Flood Mitigation Project and it must be implemented in an economically justified manner. Therefore, the project is limited to infrastructure project features and the homes with the lowest habitable floors that could be acquired for $35 million. While the property, which is to be purchased**,** has not been proven to be adversely impacted by the proposed with-project operations, the property would clearly be impacted during a full powerplant release under ice conditions.

The project consists of either buying or flood proofing property with the lowest habitable floor based on the project profile. The property owner will have their choice. The only limitation on flood proofing is that it does not exceed the fair market value of the property involved or between 125 and 150 percent of the government estimate for the least cost flood-proofing alternative.

Though the authorizing legislation states we "...may acquire from willing sellers..."---in some instances, the district may have to acquire clear title by condemnation or other judicial proceedings. Also, in the event sellers are willing to sell but we are unable to reach agreement on the purchase price, we may mutually agree to use condemnation to resolve the difference in valuation and establish the purchase price. This use of condemnation would still meet the intent of willing seller purchases and comply with the legislation.

As part of the project, some public sewer lines and roads will have to be modified. The approved report indicated that the utility raises would be completed by using 33 U.S.C. 633 to contract with the cities. However, after further evaluation, the Omaha District recommends that the infrastructure project features be constructed under the authority of this approved project.

Project Profile

The project profile was established as the bankfull profile through coordination with the public, city officials and congressional staff as the highest water surface elevation level agreeable for the maximum project. This project level has since been retracted by both cities as unacceptable and caused a 3-month delay in implementation of the project. The Agricultural Risk Protection Act of 2000 bridged the project implementations "gap" created when the cities no longer supported the project. It requires project implementation without the cities accepting

the project level. The legislation will ultimately reduce the costs that must be economically justified and results in a lower increase in Operations under ice conditions.

Selected Properties

The authorized $35 million project level could purchase or flood proof between 117 and 159 properties in Pierre and Fort Pierre. This estimate was refined to be approximately 130 properties prior to July 2000**.** The first 63 homes designated to be bought out or flood proofed were selected on the basis of the lowest habitable floor elevation. The second set of 67 homes is the remaining homes estimated that could be acquired with the $35 million authorized under this project. More residences have been surveyed and possibly would be included in the project if there are additional monies authorized some time in the future by Congress.

Floodproofing

The most likely flood proofing technique would be to fill the existing basements and raise the structures to allow for a new basement under them. The new basements would be constructed such that the lowest habitable floor is raised at a minimum, 1 foot above the future 100-year open water profile elevation or 1 foot above the 100-year base flood elevation established by FEMA at the time of construction, which ever is higher. Then fill and landscaping could be placed around the new basements. Another alternative would be to fill in the existing basements and recapture the lost square footage by building on to the side of the house at a minimum, 1 foot above the future 100-year open water profile elevation or 1 foot above the 100-year base flood elevation established by FEMA at the time of construction, which ever is higher. This elevation was selected to insure that these homes would be protected from the 100-year flood event for a reasonable length of time in the future. Only 3 out of 22 homes desiring to flood proof in the first 63 had their first floor below this elevation. Most homes in the project have adequately high first floors. It is the basement elevations that result in the lowest habitable floors well below the project level.

The flood proofing process consists of the Corps providing the homeowner with a general package (draft agreement, scope of work & picture depicting a conceptual design) outlining the key flood proofing requirements instead of detailed plans and specification. The homeowner will be required to work with a contractor following local building codes to develop the flood proofing plans and specifications. The Corps will review the homeowner and contractor package and will approve the critical elements of the package necessary to adequately flood proof the property.

The goal of the flood proofing is to minimize future flood damage and make the homeowner whole. As discussed below this means to maintain the properties original appraised value and insure that the home is adequate in size to accommodate the occupants and functionally equivalent. This does not mean that the square footage from the basement will be replaced on the first floor. This will be accomplished by performing appraisals both before and after the flood proofing work is completed. To qualify for flood proofing the Corps least cost flood-proofing alternative must be less than the appraised value. The Corp will evaluate each homeowner flood proofing proposal to; determine if minimum conditions are met, determine the fair price, and determine what items are betterment. Flood proofing estimates will be based on using the same

construction methods and materials used in the existing construction. The Corps of Engineers will not pay for betterments.

Flood Proofing Cost Limits

The **maximum** amount to be invested in flood proofing will be the appraised value of the property or between 125 and 150 percent of the Corps least cost flood-proofing alternative. The flood proofing proposals will be evaluated in the cost ranges:

Flood Proofing Cost Limits

Code	Cost Ranges	Actions on Proposal Review
n/a	**$0 to COE Estimate**	**Evaluate to verify Flood proofing minimums are met**
green	**COE est. to 125% of est.**	**Verify minimums met and identify betterments if any**
yellow	**125% to 150% of COE est.**	**Verify minimums met, identify betterments, evaluate justifications for costs as proposed**
red	**Greater than 150% of COE est. or appraised value**	**Reject proposal, identify areas of disagreement and propose alternatives to lower the costs to an acceptable range.**

The homeowner does not automatically receive the appraised value to flood proof. They are entitled to the amount necessary to bring the property value back to the original appraised value. The homeowner will not necessarily receive the same square footage as in their original home. The value of basement square footage is 50 to 75 percent less than the value of above ground square footage. While each proposal will be evaluated on a case by case basis, the District does not believe that exceeding more than between 125 and 150 percent of the governments least cost flood proofing alternative is reasonable. If the investment in flood proofing exceeds this amount, it will likely result in a significant windfall to the property owner. For example if the appraised value is $300,000 and the home can be flood proofed for $120,000, it is unreasonable for the Corps to support flood proofing in **excess** of $180,000. Although the $180,000 is significantly less than the appraised value, placing $180,000 into a $300,000 home would most likely result in the after construction appraisal being more than $360,000. This would result in a windfall profit of more than $60,000 to the homeowner and any investment and windfall larger than this would be considered unreasonable and excessive.

Betterment Definition

The term "betterment" shall mean a change in the design and construction of an element of the flood proofing resulting from the application of standards that the Government determines exceed those that the Government would otherwise apply for accomplishing the design and construction of that element. Those items required to flood proof the home, those elements required by code and those elements required to reasonably integrate the new construction with the existing construction shall not be considered betterments. Those items of higher quality or standards than required and items not required but desired by the homeowner will be considered betterments.

Essential Utility Raises

In situations where essential utilities lie below the lowest habitable floor but the lowest habitable floor is above the project level, that home is eligible for a utility raise only, unless it is determined that the cost of the utility raise and impacts to the property in completing a raise would be significant. Significant is defined as greater than 50%. Impacts are considered significant if the costs exceeding 50 percent of the (structure value) which is the appraised property value less the lot value and/or if the utility raise requires a significant modification to a significant number of rooms in the house or significant foundation modifications. If the utility raise is found to significantly impact the property, the property owner will then be offered the option to sell the property to the Corps of Engineers or have the utility raise completed. However if the utility raise is estimated to cost more than the appraised value, then only the buyout option is available.

Infrastructure Project Features

The project includes up to $9.58 million in infrastructure construction in the Pierre and Fort Pierre area. One third of each annual appropriation for this project shall be allocated to infrastructure until the infrastructure work has been completed. The infrastructure improvements will provide protection from surface water for those properties not provided assistance through the project. All the infrastructure needs identified including road raises, storm sewers and sanitary sewer lines be considered project features implemented using the existing project authority under Public Law 105-277, 112 Stat 2681 (Section 136), as amended by Section 258 of the Agricultural Risk Protection Act of 2000.

Since the infrastructure work will be completed by the non-federal interest, they are responsible for the design and construction of all work. The government over sight will be limited to assuring compliance with the minimum project requirements. At the present time, the cities have been asked to identify the needed infrastructure changes and estimate the costs assuming that the Omaha District would operate Oahe releases at the bankfull water surface elevation annually for a 3-week winter period. The Cities have completed engineering reports identifying the required infrastructure needs.

ECONOMIC ANALYSIS

Oahe hydropower production computations were all based on a pool elevation of Lake Sharpe at 1421 msl. and Lake Oahe at 1603 msl. The difference between the with and without project conditions is an increase in release capability during ice conditions.

The economic analysis is based on the comparison of the current power production and that which the alternative plans could produce to the no action alternative. It provides a minimum estimate of the hydropower values that would be realized from implementation of the proposed project. The channel icing creates problems with the flows from the Oahe project and significantly reduces the capacity and energy that can be generated at this project. This is an event that on average is anticipated to last 3 weeks annually and can occur anytime over the 3 month winter period. All recent events have happened in the January time.

Western Area Power Administration (WAPA) has not purchased capacity in the past to cover the capacity loss during the ice event. They have, however, had to purchase energy to meet their marketing contract requirements. The cost of this replacement energy has been in the $40/MWh range to reflect the high demand during the cold ice constrained period. WAPA is considering purchasing capacity to cover this problem since it is occurring more frequently. For this analysis it was assumed that WAPA will maintain the reliability of the Federal power by purchasing capacity during the winter time frame.

It was determined to be unlikely that new thermal capacity would be built to compensate for the Oahe ice constraint problem. The Oahe project is in the Mid-Continent Area Power Pool (MAPP) region, which has its peak demand period in the summer months. Over time additional capacity will be built to meet the summer load, and this capacity will be available (at a price) to support the winter peak. It was thus assumed that WAPA would be able to purchase capacity on a monthly basis to maintain the reliability of their supply and meet any reserve requirements. This would probably take the form of a long-term contract for guaranteed capacity on a monthly basis. Since the icing problem could occur at anytime during the winter, it is reasonable to assume they would contract over a 2 to 3 month period.

The purchase price would depend on many variables and would likely change over time. WAPA can currently purchase capacity in the winter at a $4/kW-month rate. This cost was compared to the monthly costs of combustion turbine plants based on the Corps' standard costing approach using FERC data. The annual costs with FERC procedures at 7.375% were estimated at about $58/kW-year. On a monthly basis this would be about $5/kW-month. Based on this review the $5/kW-month value for purchasing capacity was used to be consistent with other Corps studies.

The analysis assigned a cost associated with the energy that would have to be replaced during the icing event. However, the analysis accounts for the fact that this energy is not lost, but is held in the reservoir and can be used for generation at a later period. The value of the energy forgone is the difference in the value of the energy that will have to be purchased during the icing event and the selling price of the energy that will be generated at a later date by the stored water. To define the value difference the market price approach was used. A wholesale market is developing throughout the country that prices short-term energy sales as the marginal cost of the system.

The marginal cost during this period was based on the cost of Combined Cycle (CC) plants, the last resource used to meet load. Averaging over the 4 weeks in January, the marginal cost was estimated as $47.70/MWh. This compares favorably to the purchase prices that WAPA incurred. WAPA has purchased January energy in the past in the $40/MWh range. The value of the energy that would be sold at a later date was based on what WAPA has recently sold it at. The average price WAPA receives in the February-March time frame is $20 to $25/MWh.

Table 1 provides an estimate of the Oahe hydropower benefits using assumptions based on the discussion above. The assumptions made in the computations are summarized below:

1. Some energy would be lost because of holding waters and the need to evacuate quickly.

2. The value of the energy during the winter ice period would be based on the marginal costs of the system at that time of the year.

3. The energy withheld during the ice constraint was assumed to be generated later. The value of the energy in the later period is a variable and is based on the average WAPA selling price. WAPA provided the average market value of $20 to $25/MWh.

4. New capacity would not be built to replace the capacity lost during the ice conditions. This is primarily because in the MAPP region the peak capacity is based on the summer loads, and as new capacity is built to meet the summer peaks it will be available on a purchase or contract basis in the winter.

5. The value of lost January capacity would be based on a purchase rate on a kW-month basis. The value would be $5/kW-month. It was assumed this would be contracted for by WAPA to provide a reliable capacity during the winter ice period.

6. The risk of icing is not only in January. A variable is used to estimate how many months WAPA would contract for capacity.

Period of ice Reduction (days)	21
Percent reduction in energy to be generated (Spill)	5%
Winter peaking energy value ($/MWh)	47.7
Surplus energy value ($/MWh)	20
Capacity purchase cost ($/kW-Month)	5
Number of moths capacity would be purchased	3

TABLE 1
SUMMARY COMPUTATIONS
PIERRE ICE PROBLEM (OAHE PROJECT)
ALTERNATIVE EVALUATION
BASED ON DISCUSSIONS WITH WAPA

LOSS IN MW	JAN ENERGY LOSS (MWh)	FEB ENERGY GAIN (MWh)	JAN CAPACITY LOSS (MW)	JAN ENERGY VALUE (S)	FEB ENERGY VALUE (S)	CAPACITY VALUE (S)	TOTAL ANNUAL VALUE (S)	PRESENT VALUE
100			100					
	50,400	47,880		(2,404,080)	957,600	(1,500,000)	(2,946,480)	(40,557,796)
200			200					
	100,800	95,760		(4,808,160)	1,915,200	(3,000,000)	(5,892,960)	(81,115,593)
300			300					
	151,200	143,640		(7,212,240)	2,872,800	(4,500,000)	(8,839,440)	(121,673,389)
400			400					
	201,600	191,520		(9,616,320)	3,830,400	(6,000,000)	(11,785,920)	(162,231,185)
500			500					
	252,000	239,400		(12,020,400)	4,788,000	(7,500,000)	(14,732,400)	(202,788,981)

Table 1 shows the present value of restoring capacity for the 3 week ice constrained period as $40.6 million per 100 MW.

Table 2 adds to the values in Table 1 the estimated value of the reduction in the hydropower constraint under open water conditions. In 30 years, the power plant open water rates are expected to be constrained from the current capacity of 57,000 cfs down to 44,000 cfs under without project conditions. Under with project conditions, the current capacity of 57,000 cfs would be reduced down to 50,000 cfs. This constraint is based on the operating policy of not exceeding a bankfull elevation. The value of the reduction of dependable capacity of the plant was determined using a cost of $78/kw-yr, based on a combined cycle plant as the replacement source. The present value of the loss was calculated, based on a straight line application of the constraint from zero today to the full constraint level in 30 years. The present value of the difference in capacity (6,000 cfs with an average Oahe summer pool elevation of 1607 ft msl) using the same interest rate as above 7.375% for a period of 50 years with a straight-line reduction in capacity over the first 30 years is $33.38 million. Only capacity benefits are included in this calculation. A degradation of energy value due to a reduced level of peaking service as not computed. The plant factor during an average July and August peak demand period would be degraded from 57% to 72% under future without project conditions and from 57% to 64% under with project conditions.

TABLE 2
SUMMARY COMPUTATIONS
BENEFIT TO COST ANALYSIS

Protection Level	Future Discharge under Ice with 2 feet of Buffer	Future Open Water with 0.75 feet of Buffer min. constrained to Bankfull of 1427.30 ft msl	MW Produced	MW Difference from Existing Condition 2 feet of Buffer	Value of Power Produced $Million	Incremental Value From Existing Condtion $Million	Value of Removing Open Water Constraint	Cost to Buyout Area Covered by Water $Million	Benefit to Cost Ratio
1427.30	19488.00	44000.00	251.01		$102,109,013			$0	
1428.56	25000.00	50000.00	322.00	70.99	$130,989,600	$28,821,940	$33,380,111	$1,558,020	39.92
1428.96	26925.00	50000.00	346.79	95.78	$141,075,799	$38,888,304	$33,380,111	$27,270.175	2.65
1429.05	27350.00	50000.00	352.27	101.26	$143,302,622	$41,110,748	$33,380,111	$35,000,000	2.13
1429.30	28500.00	50000.00	367.08	116.07	$149,328,144	$47,124,420	$33,380,111	$55,913,961	1.44
1429.47	29400.00	50000.00	378.67	127.66	$154,043,770	$51,830,722	$33,380,111	$70,116,052	1.22
1432.93	57000.00	50000.00	734.16	483.15	$298,656,288	$196,158,900	$33,380,111	$201,085,117	1.14

Note: 57,000 cfs discharge has only 0.75 foot of buffer. This is considered adequate since the powerhouse would be wide open. Open water discharges currently operate with this margin of safety.

Under ice conditions the current project operations are constrained to keep from exceeding alert stages approximately 2 feet below the top of bank. At River Mile RM1065.54 the alert stage is at elevation 1425.3 ft msl. Future conditions without a project will require constraining open water discharges to 44,000 cfs to maintain the current buffer of 0.75 feet from top of bank.

The full winter time release project level would allow 57,000 cfs to be released during the ice constrained period as compared to the future without project limit of 19,488 cfs. The cost of this project level is estimated to be $201.1 million if the area is bought out to a level of 0.75 feet above the projected water surface. The additional discharge under ice conditions would result in approximately 483 MW additional hydropower production. Based on the present value of $40.6 million/100 MW the value of the full winter time release project level would be $196.2 million. The benefit associated with removal of 6,000 cfs open water constraint is valued at $33.38 million. The resulting benefit to cost ratio would be $229.58/$201.1=1.14. The benefit to cost ration (B/C) of 1.14 indicates that the full winter time release project level is also economically justified. Table 2 shows the authorized funding project level of 35,000,000 is also justified.

For purposes of determining the economic justification in compliance with the Agricultural Risk Protection Act of 2000, the economic analysis includes an assumption that the Federal Government is responsible for mitigating any existing ground water flooding. This has been interpreted to mean that the protection costs for economic analysis should not include costs associated with those facilities and properties that have an existing documented ground water problem. It is estimated based on the appraisal reports and survey noted that approximately one-third of the properties have a documentable ground water problem. Therefore one third of the estimated cost could be removed from the project cost.

RELOCATIONS AND UNIFORM RELOCATION ASSISTANCE COSTS

The provisions of Public Law 91-646 are not mandated for this project since participation by homeowners is voluntary. However, the decision was made by Omaha District to make the relocation benefit provisions of Public Law 91-646 apply to the fee acquisition component of this project to gain more project participation. For flood proofed properties, temporary storage of personal property and temporary housing will be incorporated into the owner's agreement with their flood-proofing contractor, as necessary.

Definition of Comparable Home

The project was implemented appraising homes in their existing condition. Therefore a comparable home will be based on the home identified in the appraisal. If for an example, the appraisal of a home does not recognize the two rooms in the basement as bedrooms and the home has three bedrooms upstairs then a comparable home would be 3-bedroom home and not a five-bedroom home. If the basement was not finished due to its wet condition it will be compensated for with a finished basement in the replacement home.

Definition of Safe Replacement Housing

Building on lots in the floodplain must be considered safe if the construction meets the codes established by the cities. Although not preferred, the Corps can not keep people from building on the lots adjacent to the river as long as they build to the codes that have been adopted by the cities and are more stringent than FEMA's requirement. Although strongly discouraged, the District can not keep people from acquiring property below the project level if that property is not one of the 130 identified to be purchased by the project. The District can require through the purchase agreement with the homeowner that the homeowner not relocate the salvaged property within any flood plain designated by FEMA or the Corps. This however, does not guarantee that a third party could not acquire the property and place it in the floodplain as long as they comply with local building codes

Housing of Last Resort (HLR)

It is estimated that approximately 130 homes will be included in the project. As the costs of Housing of Last Resort, allowable flood proofing costs and other costs increase, the estimated number of properties may be revised down. According to the Hughes County (Pierre) Director of Equalization, about 170-180 homes are bought and sold each year. As of early 1999, there were 55 homes for sale in Pierre and another 11 homes for sale in Ft. Pierre ranging in price from $25,000 to $250,000. In addition, there are 49 lots for sale in Pierre and 59 lots in Ft. Pierre, which are currently available for new construction. Typically, 15 to 25 new homes are constructed each year. There were 25 permits issued in Pierre in 1997 and 16 in 1998. Average price of new home construction has been in the $60-$80 per square foot range. Pierre and Ft. Pierre have traditionally had a tight housing market with a total population of around 14,000 people. It is uncertain at this time whether adequate comparable housing will be available to everyone.

Reliance on new construction to meet these needs, however, could mean that they will not be "comparably priced." The need for Housing of Last Resort (HLR) would then come into play.

Though there are several means of accomplishing HLR, government construction of the needed property would not be cost effective and the least expensive method to obtain HLR would probably be accomplished by an increase in the payment limits. The higher demand for housing may increase new construction costs resulting in the need for replacement housing payments in excess of the maximum $22,500 payment limit. This situation will be closely monitored and a request for HLR in the form of increased payment limits processed by the District, if appropriate.

In initial negotiations, it appears that as many as 1/3 of the first 63 landowners will request HLR. For example, a homeowner with a 3-bedroom house appraised at $69,500 has requested compensation to build a new home for $206,350. It was determined that more than $50,000 in costs were for betterments but construction would still cost $156,500 for a new three bedroom home. However, there are approximately 6 possible comparable homes on the market ranging in price from $110,000 to $139,900. Therefore it is likely that a payment of $70,000 in addition to the appraised value would be needed to place this homeowner in a comparable dwelling. Housing of Last Resort reports and requests will be forwarded to HQ by the District on a case by case basis.

ATTITUDE OF OWNERS AND NEIGHBORHOOD

Several public meetings have been held in the Pierre and Fort Pierre area. Attendance has been very successful. Responses obtained from a Buyout questionnaire indicate a relatively high number of property owners in southeast Pierre are interested in a buyout. The remaining homes in the area would need to be flood proofed against potential increases in flood elevations. In the Fort Pierre area, responses indicate a relatively high number of property owners are interested in remaining in their current location.

Future Use of Acquired Land

The properties will be purchased and owned by the Federal Government and managed by Omaha District Corps of Engineers. Though owned by the Federal Government, the land could be leased to cities, counties, or other entities for various uses as allowed by the legislation. Future land uses have not yet been determined but the authorizing legislation will require that the land be held by a public agency for a compatible use with a flood plain designation.

Relocation of Structures

If the landowners elect to relocate their existing property, the property will be purchased from them at fee value and the landowner will then purchase it back at salvage value. Once this is done the landowner has 1 year to remove the property from the premises. Where comparable decent, safe, and sanitary housing is available and the displaced person makes such election to move their property, the cost of living in such interim housing is not reimbursable. If comparable decent, safe, and sanitary housing is not available then the landowner may be eligible for reimbursement of temporary housing and other expenses. At this time it is reasonable to assume that there will be adequate comparable decent, safe, and sanitary housing available.

Property purchased from the Corps of Engineers cannot be relocated into a 100-year flood plain as identified by the Corps or FEMA. This restriction, however, cannot cover subsequent sales.

RECOMMENDED ESTATE AND AGREEMENTS

FEE

A fee simple title to tract's will be acquired subject, however, to existing easements for public roads and highways, public utilities, railroads and pipelines.

Condemnation proceedings will be used to clear title problems for resolution of fair market value with landowner concurrence. This would only be used as a last resort, and avoided if at all possible.

FLOOD PROOFING AGREEMENT

The Omaha District under advisement from the Division and Headquarters modified the model agreement used by Huntington District for flood proofing. The property owners electing to flood proof will enter into the agreement with the Omaha District. The agreement will be recorded in the county of record and no additional real estate interest will be acquired. The agreement will prohibit construction for human habitation below a certain elevation and it will be a covenant that runs with the land.

FLOWAGE EASEMENT

Pertaining to potential flooding, the Omaha District's plan is to operate within the channel. Anticipated infrastructure modifications and fill in of existing low bank areas are projected to prevent any overland flooding from overbanking during winter-time ice jam events. Therefore, no overland flooding as a result of hydropower releases is considered possible. There is sufficient protection of future construction on flood proofed residential properties under clause #6 of the model flood proofing agreement. For groundwater, the Corps has been unable to conclude there is a connection between river levels and groundwater levels despite extensive study. For instance, there are numerous examples in the area where some homes experience wet basements during normal or low river events, with no water problems during high flows. Vice versa, there are situations where homes in a subdivision situate at a lower elevation than their neighbors experience no wet basements while neighbors whose homes are located at higher elevations have experienced water problems in their basements.

Therefore, while flowage and/or saturation easements over ownerships choosing flood proofing would protect the Government from such claims in the future, the risk is addressed by the covenant prohibiting construction below a certain elevation.

Since the infrastructure modifications will be constructed to operate under the anticipated project conditions, the Omaha District recommends that no easements or subordination agreement be required from the utility owners.

INFRASTRUCTURE RELOCATION AGREEMENT

The District, under advisement from the Division and Headquarters, has elected to use a Relocation Agreement as the instrument to accomplish the infrastructure project features.

PROPOSED CONSTRUCTION & RESTORATION

This project does not include any Corps of Engineers construction or restoration plans. The estate being sought is fee simple title or flood proofing. No cemetery relocations are anticipated at this time. Considerable effort will be placed on the establishment of project boundary lines to assure that all remaining properties will not be cut-off from access roads within the Pierre and Fort Pierre project.

Any land that is acquired under this project pursuant to the authorizing legislation must be kept in public ownership and will be dedicated and maintained in perpetuity for a use that is compatible with any remaining flood threat. Both cities and property owners have voiced concerns of vacant patchworks of property remaining after the homes are purchased. The Omaha District and the cities are concerned about the future operation and maintenance costs for the property acquired by this project. Unless this land is leased or disposed of to another public entity, the Corps will be required to maintain the random lots within the communities. The cities and the property owners are concerned about future devaluation of their property values as a result of the project. While the cities may be interested in acquiring leases for some contiguous lots, the vast majority would be of no value to the cities because the future development must be in accordance with the floodplain building codes, and must be consistent with the authorizing legislation and current FEMA policy on flood mitigation projects.

Operation and Maintenance Plan (O&M)

It is not feasible at this time for the Government to develop a detailed O&M plan for managing or outgranting the land purchased. When the number and location of acquired properties become more apparent, the District will be able to further study and develop an appropriate O&M or disposal plan.

Three of the properties being acquired immediately do not include a reservation for the seller's continued occupancy of the properties beyond the closing date. The sellers have already vacated these properties or will be able to vacate the properties within a short period of time. Since the United States will acquire immediate possession of the some of these properties, the District is beginning to develop the operation and management plan associated with acquiring these properties and ultimately disposing of the properties.

Immediately following the closing and transfer of the properties, the Real Property Accountable Officer will transfer custody and care of the property by hand receipt to an

individual in Operations. The hand receipt holder will be the Oahe Project Manager. Upon acquiring possession, the Corps will become immediately responsible for mowing the grass, spraying and controlling weeds, snow removal, winterizing the house, security from vandalism and repairs associated with vandalism. There will be an unknown holding period associated with these properties, while the project completes the required environmental documentation necessary to support disposal of the houses. Preliminary asbestos and lead based paint surveys have been completed but additional work will probably be required for all houses and lead based paint remediation may be required, for those houses built prior to 1978. Once the houses have been found suitable to transfer, the properties need to be screened with other DOD and federal agencies for approximately 30 days. Subsequent to that screening, the properties will have to be reported to HUD for screening with homeless providers. That screening period is 60 days. The holding period for these houses will likely be six months or longer. The Flood Mitigation Project funds will be used for these actions. Until the project is completed and no Construction General funds are available no Operations and Maintenance funds will be expended on the project.

THE FLOOD PROOFING PROCESS

The flood proofing process for this project is as follows:

- Preliminary Corps site inspection
- Corps develops a proposed flood proofing alternative
- Corps develops a basic Homeowner's package:
  - Computer simulation of flood proofed home
  - Site plan
  - Scope of work
- Corps develops a cost for flood proofing to compare to appraisal value; for Corps' internal use only
- Corps will meet with Homeowner to explain the proposed flood proofing alternative
- Feedback from Homeowner about the proposed flood proofing alternative
- If the Homeowner requests substantial changes, then a second basic Homeowner's package will be developed
- Or the Homeowner will submit a flood proofing proposal to the Corps
- A more detailed site inspection will be completed on the homes of those who decide to flood proof
- Corps develops a detailed Homeowner's package:
  - Computer simulation of flood proofed home
  - Site plan
  - Scope of work
  - Sketches
  - Supplemental specifications
  - Contractor's cost estimate sheets
- Or the Homeowner submits a flood proofing proposal complete with site plan, sketches, scope of work, Contractor's cost estimate sheets. etc.
- Homeowner requests construction proposals from Contractor

- Corps prepares an independent cost estimate
- Or Corps reviews Contractor's cost estimate submitted with Homeowner proposal
- Corps reviews Homeowner proposal
- Corps makes an offer to the Homeowner
- Homeowner accepts Corps' offer
- Homeowner negotiates with Contractor
- Corps reviews the negotiated Contractor proposal
- Flood proofing agreement is executed between the Corps and Homeowner
- Execution of construction contract between Homeowner and Contractor
- Construction
- Inspection during construction
- Final Inspection
- Closing and one time payment to the Homeowner and Contractor

PRELIMINARY HOMEOWNER'S FLOOD PROOFING PACKAGE

An example homeowner's package is as follows: The intent of this preliminary package is to show the homeowner a flood proofing alternative that restores all of the home's square footage, what it will look like when complete, and what generally must be done to achieve the elevated home.

FLOOD MITIGATION PROJECT
PIERRE AND FORT PIERRE
SOUTH DAKOTA

PRELIMINARY HOMEOWNER'S PACKAGE

CHANGE IN HOUSE ELEVATION

TABLE OF CONTENTS

Elevation of the existing house is proposed because construction of an addition was not an option due to the limitations of the existing lot size. The existing first floor of the house will be elevated approximately 6.6 feet. Your basement, as it exists today, will be replaced with the

house elevation option. Betterments will not be paid for by the Government. The photograph depicting the elevated house may show betterments that you may want to consider for aesthetics.

REQUIRED ITEMS

Demolition of basement interior
Temporary housing
Temporary construction fencing
Remove porch and deck
Detach garage and sun porch
Flood proof garage
Fill inside of basement with sand/gravel
House jacking
Remove basement windows
Masonry block in basement windows
Replace water softener
Replace furnace and air conditioner
Replace water heater
Unhook, extend, and re-hook water, electrical, sewer, and gas
Breakup existing basement concrete slab
Repair sidewalks
Construct interior stairs
Deck repairs, replacement
Repair garage separation
Add a vapor barrier in basement
New windows in raised basement
New sod
New carpeting in raised basement
Add pipe column footings
New drywall ceiling system in raised basement
New concrete slab floor system in raised basement
Temporary storage of basement items
New 2X6 exterior stud walls in raised basement
New 2X4 interior stud walls in raised basement
New bathroom in raised basement
Construct a tornado shaft
New doors to access the raised basement
Replace interior of raised basement to match the existing basement

SCOPE OF WORK

ELEVATION OF EXISTING HOUSE

HOMEOWNER:

ADDRESS:

All construction shall be in accordance with the State, County, and City Building Codes. Supplemental specifications are attached and shall supercede any of the above mentioned Codes.

Relocate all existing basement and outside utilities (e.g. heat pump or air conditioner) above Elevation 1433.1 NAVD 88.

Raise the existing house first floor 8 feet above Elevation 1433.1 NADV 88 to the bottom of the existing floor joists.

Attached garage shall remain at the existing elevation. Attached garages shall be separated from the house and reconnected following the raise.

Any existing foundation walls below Elevation 1433.1 NADV 88 must have the same material as the new foundation walls.

All foundation wall openings below Elevation 1433.1 NADV 88 shall be filled with concrete or concrete masonry units the same thickness as the existing foundation walls.

Demolish all existing partition walls, ceiling finished, existing foundation wall finishes, wall mounted electrical wiring and plumbing in the existing basement. Interior load bearing walls shall be replaced with concrete or concrete masonry unit construction.

New interior structural support columns shall be placed on footings in the exact location as the existing support columns. The new support shall be pre-manufactured adjustable steel pipe columns.

Break up any existing concrete crawl space floor slab by completely drilling through with a 3/4 inch diameter bit at 12 inches on center each way to provide drainage.

Construct a vertical shaft of 8 inch concrete masonry units 5 feet by 5 feet from the raised house first floor (Elevation 1433.1 NAVD 88) a maximum of 6 feet deep. Parge coat both the interior and exterior surfaces of the shaft from top to bottom on all sides. The location of the shaft shall be provided by the homeowner.

The existing basement shall be backfilled with sand/gravel, a vapor barrier placed over the backfill, and a new 4 inch thick concrete slab placed over the backfill and vapor barrier. The top of the new concrete slab shall be at Elevation 1433.1 NAVD 88.

The space below the raised first floor (new basement) shall be finished the same as the existing basement. Utility and appliance locations shall remain the same as the existing basement plan.

The new exterior walls constructed to raise the house shall be finished the same as the existing raised portion of the house.

All existing utilities shall be extended to the raised structure.

Existing garages either attached or detached shall be wet flood proofed to Elevation 1433.1 NAVD 88. The wet flood proofing shall consist of raising all electrical components to at or above Elevation 1433.1 NAVD 88. All garage wall construction below this elevation shall be water-resistant.

All meters and service hookups shall be located above Elevation 1433.1 NAVD 88. Existing sidewalks, steps, stoops, decks, and all other appurtenances that require removal due to the house raise shall be replaced. Additional steps shall be provided where required.

Disturbed areas of the lawn shall be graded and seeded to blend with the undisturbed area.

Any existing driveway, sidewalks and other areas that do not require removal due to the utility raise and which incur damage as a result of the utility raise shall be repaired at the expense of the Contractor.

The Contractor shall remove and dispose of all debris following construction.

The Contractor shall prepare a detailed unit cost estimate including sketches and dimensions and submit to the homeowner for review prior to the contract award.

SUPPLEMENTAL SPECIFICATIONS

Interior Backfill

Existing Basement Slab. Prior to placing backfill in the basement the existing floor slab shall be broken-up or drilled using a 3/4 diameter bit at 12 inches oncenter each way for drainage.

Non-cohesive Backfill. Backfill in basement areas shall be bank-run sand and gravel, and shall be free or organic matter, top soil, and rocks greater than 3 inches in size.

Compaction. Backfill material shall be placed in level uniform layers of approximately 8 inches loose thickness and thoroughly compacted with mechanical equipment to prevent settlement.

FLOOD PROOFING AGREEMENT

A draft flood proofing agreement to be used on this project is as follows:

DRAFT

FLOODPROOF AGREEMENT

TRACT NO._____

PIERRE/FORT PIERRE FLOOD MITIGATION

PROJECT

WHEREAS, pursuant to Public Law 105-277 (section 136, Division C, Title I, of Omnibus Consolidated and Emergency Supplemental Appropriations Act of 1999), the U.S. Army Corps of Engineers, Omaha District, (hereinafter the "Government"), and (Names of Owners)_____ (hereinafter the "Owners"), intend to implement the Pierre/Fort Pierre Flood Mitigation Project (hereinafter the "Project");

WHEREAS, implementation of the Project involves the acquisition from willing sellers such land and property in the vicinity of Pierre, South Dakota, or floodproof or relocate such property as described in the report approved by the Assistant Secretary of the Army (Civil Works,) on August 12, 1999 and as further described in the ___ [ultimate name of the REDM]____, dated_____, 2000 and approved by the Assistant Secretary of the Army (Civil Works) on _____, 2000;

WHEREAS, implementation of the floodproofing component of the project includes, inter alia, the floodproofing of certain residential structures so that the habitable floors thereof are raised above project elevations;

WHEREAS, ___(Names of Owners)__ are the owners of a certain parcel of land identified by the Government as Tract No. _____, which is the same land as that described in a deed from__(insert complete source of title), a copy of which is attached hereto as Exhibit A, on which is located the residence of said Owners consisting of a (describe structure)_____;

WHEREAS, it is the desire of the Owners to participate in the floodproofing component, and receive the benefits, of the Project;

NOW, THEREFORE, THIS AGREEMENT AND GRANT made and entered into by and between (__insert names of owner, tenants and lienholder(s) and the United States of America;

WITNESSETH, That for and in consideration of the premises and the mutual agreements and covenants hereinafter set forth:

1. The Government, herein represented by the Chief, Real Estate Division, Omaha District, U.S. Army Corps of Engineers, hereby agrees to pay reasonable and legitimate expenses involved in floodproofing said structure as hereinbefore stated, not to exceed $_____, subject to the availability of funds and to the submission by the Owners of appropriate expense documentation as may be required by the Government. The Owners shall permit an inspection or inspections of the floodproofing work by the Government, its contractor, assigns or representatives upon completion of the work, and at any time during the work's progress, to ensure that the work is acceptable to the Government and has been satisfactorily performed to meet the Project's criteria as to design, construction, and protection prior to payment. Provided further, that all floodproofing work must be done in accordance with all applicable building codes by a licensed contractor approved by the Government within 180 days of the date this

agreement is accepted by the Government; and further, that such work shall be performed in accordance with the Scope of Work attached hereto as Exhibit B and estimates previously approved by the Government. Provided, further that the payment shall be made by Government issued check payable to the Owners and said contractor jointly. Provided, further, that, should the Owners incur any cost in excess of said amount, such excess cost shall be borne by the Owners unless such additional amount is expressly approved in writing by the Government as necessary for floodproofing the structure.

2. The Owners hereby agree that the Owners' written agreement(s) with the contractor performing the floodproofing work on said structure shall include the following provision:

(a) "The contractor agrees to keep separate individual cost accounting records detailing both direct and indirect costs in connection with the floodproofing work. The Contractor also agrees to make such records available to the U.S. Army Corps of Engineers or other representatives of the United Sates of America, upon demand so that contract costs my be evaluated. The cost evaluation will be performed using generally accepted account standards and auditing policies and criteria."

(b) "The Contractor agrees that all floodproofing work will be accomplished in accordance with the Scope of Work previously provided by the U.S. Army Corps of Engineers before payment is made to the Contractor."

3. The Owners hereby agree that the Owners shall not convey to any third party any interest in and to said land or the residential structures located thereon, nor create any liens thereon prior to completion of said floodproofing work and recordation of this Agreement by the Government in

the land records of Stanley County, South Dakota, without the prior written approval of the government.

4. The Owners hereby acknowledge that the amount set forth in Paragraph 1. above, is based upon a proposal obtained by the Owners from (insert name and address of Contractor); that it is the Owners' desire that (insert name of Contractor), perform the work necessary in connection herewith; that the Government has made no warranties or guarantees whatsoever in connection with the Contractor or with the Contractor's ability to satisfactorily perform the work; and, that, as between the Government and the Owners, the Owners are solely responsible to arrange for the Contractor's satisfactory completion of the work in accordance herewith.

5. Further, that for and in the consideration aforesaid, the receipt and sufficiency of which are hereby acknowledged, the Owners, for themselves and their heirs and assigns, do hereby GRANT, unto the Government, and its assigns, the perpetual right, power, and privilege of access to said land and any structures thereon at all reasonable times considered necessary by the Government, its contractors, assigns or representatives to ensure that this Agreement, its covenants and restrictions, and the intents and purposes of the project are being complied with by the Owners, their heirs and assigns.

6. The Owners, for themselves and their heirs and assigns, hereby covenant, agree and warrant to the United States, and to its assigns forever, that no construction, alteration, or placement of structures of any kind or nature whatsoever on said land shall take place unless the lowest floor thereof to be used for human habitation, commercial or business purposes is elevated above_____feet NAVD 1988; and that this restriction constitutes a covenant which runs

with the land and is perpetual and binding on all parties and all persons claiming under them, and said restriction shall be specifically included in every instrument subsequent hereto conveying title to any interest in, or creating any lien or encumbrance on, said land or structures thereon.

7. The Owners, for themselves and their heirs and assigns, hereby covenant, warrant, and agree that they will forever hold and save harmless and blameless the United States and its assigns, from any damages or injuries resulting either directly or indirectly from any floodproofing work.

8. The (name of lienholder) join(s) in the agreement for purposes of consenting to the terms of this agreement and subordinating its rights to Tract No. _____ arising out of that certain (here specifically describe the lien) to the easement and other rights and restrictions herein acquired by the Government.

9. (name of tenants) join(s) in this agreement for the purposes of consenting to the terms of this agreement and subordinating their rights as tenants to Tract No. _____.

10. It is further provided that the obligations of the government herein are contingent upon the Owners obtaining, as may be acceptable to the Government, the consent of any lienholder or tenants to the terms of this agreement and obtaining from any lienholder or tenants waivers, releases, and/or subordinations of their rights in the premises to the extent necessary, to accomplish the work and covenants and restrictions herein, as may be required by the Government.

IN WITNESS WHEREOF, the parties have executed this Agreement and Deed effective as of the date of acceptance by the Government.

ACCEPTED:

By: _____
Chief, Real Estate Division
Omaha District
U.S. Army Corps of Engineers

Date:_____

_____
OWNER

_____
OWNER

_____
TENANT

_____
LIENHOLDER

ADD ACKNOWLEDGEMENTS AND OTHER LOCAL RECORDATION REQUIREMENTS

ACQUISITION/BUYOUT/RELOCATION PROCESS

The Acquisition/Buyout Process

The following describe the acquisition/buyout process:

- Real Estate Division will prepare scopes of work for Title Evidence and for Appraisal Services. Local Contractors will be invited to bid on the work.
- Select local Contract Appraiser.
- The Contract Appraiser physically inspects each property.
- The Corps of Engineers' negotiator will contact the landowners to schedule negotiations.
- The Government's Written Offer will be mailed or hand-delivered to the landowner.
- The negotiator will explain the Government's acquisition policies and procedures. The amount of just compensation will also be thoroughly discussed.
- The Corps of Engineers will give the landowners a reasonable amount of time to consider the written offer.
- When agreement on the offer is reached, the landowners will be asked to sign an Offer to Sell Real Property.
- Notice of Acceptance will be mailed to the landowners.
- Payment to the landowner and transfer of title.

Relocation Assistance Process

- A relocation counselor will contact each landowner personally during the negotiations for the purchase of their existing property to explain the relocation benefits.
- The landowners will typically select comparable decent, safe, and sanitary replacement housing within one-year of the date the Government purchases their previous dwelling. Depending on the availability of suitable replacement housing, the one-year time period may have to be extended. Any extension of time would be approved on a case-by-case basis.
- Landowners are entitled to reimbursement of moving costs.

- The landowners will typically move to their replacement housing within one-year of the sale of their previous dwelling. Depending on the availability of suitable replacement housing, the one-year time period may have to be extended. Any extension of time would be approved on a case-by-case basis.

- The landowner's replacement dwelling will be inspected by a representative of the Corps of Engineers to verify that it is comparable, decent, safe, and sanitary

- The relocation counselor will assist landowners in preparing their claim(s) for benefits.

- The claim(s) will be processed and the benefit payments will be made.

MIDDLE CREEK
LAKE COUNTY, CALIFORNIA

PROJECT DESCRIPTION

The Middle Creek Project is a Federally constructed channel improvement and levee system with levees located on the left and right banks of Middle, Scott, Clover, and Poge Creeks. The Middle Creek Project is a primary Federal flood control facility. A total of 14.41 miles of levees and levee improvements were constructed as follows:

Unit No. 1 - Left Bank Middle Creek (7.32 miles)

Unit No. 2 - Right Bank Middle Creek (3.13 miles)

Unit No. 3 - Left Bank Scott Creek (1.39 miles)

Unit No. 4 - Right Bank Clover Creek Bypass, Alley Creek, and Poge Creek (1.53 miles)

Unit No. 5 - Left Bank Clover Creek and Clover Creek Bypass (1.04 miles)

The average levee height is 7 feet, with a maximum height of 20 feet. The average levee crown width is 12 feet with patrol roads and 30 feet with public roads. The levee has approximately 1 vertical on 3 horizontal water-side slopes and 1 vertical on 2 horizontal land-side slopes. The authorized freeboard is 3 feet. The estimated protection provided by the project levees for each creek is described in Table 1.

The project levees are a component of the Middle Creek Project authorized by Congress under the Flood Control Act of 1954 (Public Law No. 780, Eighty-third Congress Second Session House Document No. 367), approved 3 September 1954. Public Law No. 780 authorized construction of levees and channel enlargements within and along the Middle, Scott, Clover, Alley, and Poge Creeks. Legislation authorizing participation by the State of California in the project was enacted under the California Statues of 1955, Chapter 1949, and is cited in Section 12656.5 of the State Water Code. The area presently subject to flooding, which is protected by the levee system, comprises approximately 2,500 acres of agricultural land, the town of Upper Lake and surrounding areas, Middle Creek Pumping Plant, Highway 20, and related buildings, residential structures, and roads.

TABLE 1
Middle Creek Project Design Flows

Creek and Reach	Project Design Flow (cfs)	Frequency (years)
Middle Creek		
Above Clover Diversion	**12,500**	**300**
Below Clover Diversion[a]	**21,500**	**200**
Below Clover Creek	**19,000**	**100**
Below Scott Creek	**27,000**	**100**
Scott Creek		
At mouth	**11,000**	**50**
Clover and Alley Creeks		
Clover Creek above Alley Creek[b]	**5,000**	**200**
Alley Creek above Clover Creek[c]	**2,800**	**70**
Clover Creek below Alley Creek	**8,500**	**200**
Clover Creek below Diversion	**500**	**200**
Diversion Channel	**8,000**	**200**

Notes:

a. Applicable to left bank only; right bank designated for 19,000 cfs (130 year frequency)
b. Applicable to left bank only; no right bank levee
c. Applicable to right bank only; no left bank levee

No Phase I PL 84-99 repairs were made to Middle Creek Project levees as a result of the 1998 flood events. As a result of flood events in 1956, PL 84-99 repairs were made to Scott Creek levees, prior to the construction of the Middle Creek Project, at a cost of $4,771. Scott Creek received additional PL 84-99-repair assistance following flood events in 1970 and 1995 at a cost of about $27,000 and $89,000, respectively. A request of PL 84-99 assistance in 1983 was rejected on the grounds of maintenance deficiencies. PL 84-99 Phase III repairs were made at three sites along Middle Creek and Clover Creek as a result of the 1997 flood events. The 1997 repair costs totaled $121,000.

PROBLEM DESCRIPTION

The February 1998 flooding was the result of a phenomenon known as the El Nino Southern Oscillation, which caused wetter-than normal conditions during the 1998 rainy season. The Middle Creek Project area levees experienced extensive and prolonged flood flows, resulting in erosion, seepage, and breaching on the left bank of Middle Creek. No damage was reported on Scott, Clover, or Alley Creeks. The February 1998 flood event lasted approximately 45 days. However, due to record snow levels, river flows remained higher than normal throughout 1998.

The following tabulation presents flow frequency data for Middle Creek in the vicinity of the Middle Creek project area at the Rancheria Road bridge. The Rancheria Road bridge is located 1.5 miles north of Upper Lake. This data is the most recent available and is based on 1997 preliminary studies. The estimated peak discharge at the Middle Creek gage during the 1998 storm was 5,720 cubic feet per second (cfs), corresponding to a flood frequency of less than 10 years.

Table 2
Frequency/Flow Data for Middle Creek

Frequency (years)	Flow at the Middle Creek Gauge (cfs)
100	**10,400**
25	**8,000**
12	**6,300**
10	**5,800**

Eight sites were damaged by the February 1998 flood event. All sites were located in Unit 1 along the left bank of Middle Creek.

Site 1. Levee Mile 0. 72-0.73

Waterside slope erosion and scour occurred at a 1997 repair site on Middle Creek. Erosion extends from the levee toe to the crown. Damage has exposed a non-woven geotextile soil stabilization mat placed during 1997 repairs. The damage exhibits a 15-20 foot vertical face above a gravelly toe. The damage measures approximately 55 feet in length. The levee bank is characterized by a steep slope and is covered by heavy grasses. Large trees were observed adjacent to the damage site. A gravel access road is located on the levee crown.

Site 2. Levee Mile 4.95

Landside emergency repairs were performed by Lake County (County) at this site during February 1998 to arrest seepage. Seepage and saturation of the levee soil reportedly caused slumping during the 1998 flood event. Emergency repair measures included placement of a geotextile blanket with a pea-gravel cover extending from the levee crown to approximately 30' beyond the levee toe. The landside levee bank is characterized by a steep slope with heavy grasses and weeds. Cattails and scattered woody vegetation were observed on the waterside.

Site 3. Levee Mile 4.90

A boil was identified near the levee crown along the left bank of Middle Creek. Significant flows were reported from the boil during the flood event, but no evidence of material loss was observed. The boil was sandbagged by the County during the flood event as an emergency measure. The levee is characterized by a narrow profile with a crown of less than 8 feet in width. The landside bank is covered with light grasses and scattered trees. Seepage was observed in a toe-ditch at the base of the levee.

Site 4. Levee Mile 4.91

A boil was identified approximately 100 feet from Site 3. Seepage is reported to have originated at base of levee and progressed to the crown as flood flows increased during the February event. High flows were reported from the boil, but no evidence of material loss was observed. The levee cross-section and embankment cover is similar to that described for Site 3.

Site 5. Levee Mile 4.82

A boil was identified midway up the levee bank near levee mile 4.82. High flows and material loss were reported during the flood event, but very little material was observed during the site investigation. The site was sandbagged by the County as an emergency measure during the flood event. The levee cross section and embankment cover is similar to that described for Site 3.

Site 6. Levee Mile 5.40-5.50

Boils were identified near the levee crown between levee mile 5.40 and 5.50. The boils were sandbagged by the County during the flood event as an emergency measure. Significant flow and material movement was reported during the flood event. Possible pipe-holes and a small amount of material was observed around the bagged area. The levee profile is narrow, similar to that described for Site 3, and the bank is covered with light grasses and weeds.

Site 7. Levee Mile 5.44-5.46

Waterside slope erosion and wavewash occurred just below the levee crown near levee mile 5.44-5.46. Several hundred feet of the levee crown was sandbagged by the County during the flood event as an emergency measure. The damage measures about 4-6 feet in height, but additional damage is suspected below waterline. Sandbags to arrest seepage were also placed on the landside during the flood event. Seepage was observed in a toe-drain at the base of the levee. The levee profile is narrow, similar to that described for Site 3, and the bank is covered with light grasses, weeds, and scattered trees.

Site 8. Levee Mile 6.60

A levee breach measuring approximately 100 feet in width occurred near levee mile 6.0. At the time of the site investigation, water levels were too high to determine the extent of levee foundation damage. The levee crown in this area is narrow, between 6 and 10 feet wide, with no vehicular access road. Heavy vegetation, including weeds, grasses, and woody vegetation is continuous along the levee crown and along both the waterside and landside banks. Landside and waterside wavewash damage was reported along the levee leading to the breach but was not observed due to the high water levels and heavy vegetation.

Structural Component: Site 1: L. M. 0.72-0.73 - The proposed work consists of restoring the damage at this site to its pre-flood condition. Any vegetative cover would be stripped and loose material in the repair section would be removed and replaced in compacted layers. Imported material would be used to restore the levee to the pre-flood grade. A soil stabilization mat would be installed on the finished repair as recommended by an authorized manufacturer's representative. Repaired or disturbed levee slopes would be hydroseeded.

For Sites 2 through 8 a structural alternative was also examined. This would consist of closing the levee breach at site 8 (LM 6.60). Construction of the breach closure will be difficult as there is no access to the site on the levees. If the water is deep enough, material could be loaded and placed by barge. Otherwise, an access road would have to be constructed through the water to the site. Once the breach is closed, the water on the landside of the levees would be pumped out.

To address the seepage and boil problems through the levees at many of the sites, a 30-wide drain and stability berm would be constructed from LM 4.96 to LM 4.81 and from LM 5.39 to LM 5.5 1. Since many of the boils were near the levee crown, the stability berm would essentially come to the top of the levee, in essence widening the levee section. Between levee mile LM 5.44 to 5.46, levee sloughing and wavewash occurred.

The estimated cost of making the structural repairs at these sites is $2,696,000, of which $2,650,000 would be the Federal cost. If this plan were implemented, along with the repair of site 1, the B/C ratio would be 1.3.

Non-Structural Component: Sites 2 through 8 - In accordance with Section 202 (e) of the Water Resources Development Act of 1996, consideration of nonstructural alternatives to the structural rehabilitation of damaged flood control works was given in conjunction with the requested Federal emergency levee restoration assistance under PL 84-99. Consideration was given to alternatives that could provide greater benefits of flood control, reduction of future potential flood damages to the applicant and adjacent upstream and downstream localities, lower long-term costs to the Federal Government, and natural resource protection, including compatibility with existing local or regional flood plain management plans.

Flood plain acquisition can be used to retire land that frequently floods to preclude Federal disaster payments, allow levee setbacks, or limit use of the land. However, all measures must be economically, environmentally, and socially defensible and technically sound. All long-term benefits must be weighed against the cost of continued damage on an average annual basis.

The Sacramento District completed the Middle Creek Ecosystem Restoration Study. The Study identified six alternative restoration plans. The plans cover all or part of the approximately 1700 acre 100-year flood plain where damage sites 2 to 8 is located.

The non-structural plan for sites 2 to 8 would consist of acquiring properties in the 100-year flood plain in fee title in a manner that would be compatible with the possible future development of an environmental restoration area within the 100-year flood plain. The plan would allow the non-Federal sponsor to immediately begin acquiring critical properties or take advantage of current offers by willing sellers to sell large parcels of land. The Corps of Engineers financial participation in nonstructural plans is limited to the lesser amount of the cost

of (1) the Federal share of rehabilitation costs of the project if sites 2 to 8 were to be structurally rehabilitated or (2) the Federal share of the benefits which would accrue from such rehabilitation.

SELECTED PLAN

The selected plan consists of using a combination of structural and non-structural measures. Structural measures are to be used at Site 1 and non-structural measures at Sites 2-8, all as described above. Costs for the selected plan are shown in Table 3.

The proposal is for the local sponsor to implement the nonstructural plan. Under current guidelines, the Corps of Engineers would provide PL 84-99 funding towards the nonstructural/environmental restoration alternative limited to the amount the Federal share of the PL 84-99 structural repair would have been. The amount that could be contributed is $2,650,00, which is the estimate of the Federal share to repair the damage at sites 2 to 8. This portion of the levee system would then be removed from the Federal flood control system and would no longer be eligible for future PL 84-99 funding.

This nonstructural/environmental restoration alternative would greatly reduce the levee maintenance responsibility of Lake County Flood Control and Water Conservation District, and would eliminate future Federal flood emergency costs by removing this portion of the levee system from being eligible for PL 84-99 rehabilitation. It would also remove people, property, and structures from the flood plain.

TABLE 3
MIDDLE CREEK SELECTED PLAN
COST ESTIMATE

	Quantity	Unit	Unit Cost	Estimated Cost
Structural Component				
Construction Costs (Federal)				
Clear & Grub	**1**	**LS**	**$8,300**	**$ 8,300**
Backfill	**500**	**CY**	**$ 35**	**$17,500**
Site constraints	**1**	**LS**	**$3,000**	**$ 3,000**
Soil Stabilization Mat	**90**	**SY**	**$ 10**	**$ 900**
Hydroseeding	**0.1**	**Acres**	**$5,000**	**$ 500**
Subtotal				**$30,200**
Contingency				**$ 3,000**
Patrol Road Damage Repair				**$ 8,850**
E & D				**$ 3,000**
S & A				**$ 3,000**
Red-legged Frog Survey				**$45,000**
Subtotal (Federal)				**$93,050**
Other costs (Non-Federal)				
Borrow	**500**		**$ 3.50**	**$ 1,750**
Total				**$94,800**
Non-Structural Component				
Federal Contribution from PL-84-99 to Non-Structural Plan				**$2,650,000**
SPK Funding to Develop PCA and Implement Plan				**$ 100,000**
Total				**$2,750,000**
TOTAL BOTH COMPONENTS				**$2,844,800**

ENVIRONMENTAL ASSESSMENT

Based on the information developed in the EnvironmentaI Assessment, this project is not expected to involve significant impacts to endangered species, important fish and wildlife resources, water quality or other natural or cultural resources. This emergency levee restoration project has been thoroughly coordinated with the California Department of Water Resources, the State Reclamation Board, the California Department of Fish and Game, the State Historic Preservation Officer and the U.S. Fish and Wildlife Service. The National Marine Fisheries Service is fully aware of these proposed levee restoration activities. The design of this project is responsive to recommended measures to avoid or minimize potential impacts to endangered species and natural or cultural resources. The Environmental Assessment addresses any impacts and mitigation requirements of the proposed work. This project is in full compliance with the emergency natural disaster provision of the Endangered Species Act. The levee restoration measures comply with the Executive Order 11988 in that the area being protected was reclaimed from the floodplain during the early part of the century. The impacts on natural and cultural resources in the project area have been evaluated and found to be less than significant.

ECONOMIC ANALYSIS

a. General Statement of Project Economics

The subject levee system protects a largely rural area of about 3,500 acres of agricultural and developed land at the design level of protection. Most land use is agricultural. Principal crops are pears, wine grapes, walnuts, pasture and wild rice. Data related to crop production costs, value of production, flood damages and land values were obtained from the California Department of Food and Agriculture (CDFA), the Department of Interior Bureau of Reclamation, and the California Farmer. Acres of principal crops are shown in Table 5. The total estimated value of crop production in the protected area is $4.2 million.

The protected area also includes the town of Upper Lake with a recent population of about 950 persons. Data on structural damages were estimated from a survey of the protected area and a benefit-cost modeling routine described in Benefit-Cost Analysis of Hazard Mitigation Projects Volume 1, Riverine Flood Hazard Mitigation Projects, prepared for FEMA by VSP Associates, 1993. The damage functions for structures and contents were developed by the COE, Lincoln District Office, from Federal Insurance Administration Claims data. For this study, it was estimated that the entire protected area includes about 356 residential structures and mobile homes, 718,000 square feet of building space of all types with a replacement value of about $30 million, and contents valued at $11 million. Details are provided in Table 5.

The analysis assumes that the levees have three feet of freeboard, and annual damage estimates assume that the levees have a 33 percent change of failure if the water level rises to between 2.5 and 1.5 feet below the top of the levee, a 66 percent chance of failure if water rises to between 1.5 and 0.5 feet below the top, and a 100 percent chance of failure if the water rises any further. Therefore, the probability of levee failure is less frequent than the recurrence interval of a water level at or above the design level.

The left bank of Middle Creek above the Clover Creek Diversion Structure has a design frequency of 1/300 and would flood about once every 1,000 years. Levee damages in Unit 1, without repair, would increase the probability of a break to about once every 125 years. It was assumed that one-quarter of agricultural benefits, and one-tenth of structural benefits could be obtained by repair of the damages in Unit 1.

b. Benefits Analysis

Benefits from the levee repair are based on damages to structures and contents, displacement costs, value of lost services, income losses, agricultural damages, cost of levee repairs, road and automobile damages, and emergency costs avoided because of the repair. The structural damage assessment includes road damages, which are presented as a separate item. Displacement costs are relocation, loss of function and transactions costs related to the type of building and the duration of displacement. Data are from a two-year study sponsored by the National Institute of Building Sciences. Income losses are business losses related to business type and time required to resume operations. Data on return to management and capital were obtained from the

Department of Commerce. Value of lost services is public service losses. Damages are based on duration of lost services and data on cost of service. Agricultural damages are lost net value of agricultural production or other costs incurred because of flooding. Costs of levee repairs following a flood are assumed to be $750,000.

Automobile damage costs and emergency costs were derived from estimates contained in the Economic Evaluation Sacramento River Flood Control System Evaluation Design Memorandum, Mid Valley Area (1996). Average annual damages avoided, capital costs of repairs, the annualized cost of repairs, and the benefit to cost ratio are shown in Table 4. Annual benefits are estimated to be $263,000.

Cost of the structural repairs are estimated to total $49,781 and the cost of the non-structural is estimated at $2.8 M. Assuming a 50 year life and a discount rate of 7.125 percent the annualized cost of the proposed action is $206,000 and the ratio of benefits to costs is 1.3 to 1 as shown in Table 4.

TABLE 4
MIDDLE CREEK ECONOMIC ANALYSIS

ANNUAL DAMAGES BY SOURCE, $1,000	
Agriculture	**$ 2**
Levee Repair	**$ 5**
Automobile Damage	**$ 0**
Road Damage	**$ 1**
Emergency Costs	**$ 1**
Structures	
Displacements Costs	**$ 61**
Income Losses	**$ 0**
Building Damages	**$122**
Contents Damages	**$ 65**
Value of Lost Services	**$ 7**
Total Annual Benefits	**$263**
CAPITAL COST, ANNUAL COST, AND B/C RATIO	
Capital Cost	**$2,800**
Total Annual cost	**$ 206**
Benefit-Cost Ratio	**1.3**

c. **Economic Checks**

Economic checks required by ER 500-1-1 were conducted and are shown in Table 5.

TABLE 5
TOTAL VALUE OF PROPERTY PROTECTED

CATEGORY	VALUE IN MILLION $
Structures and Contents:	
Residential	**$24.1**
Commercial	**$ 3.1**
Public	**$ 2.7**
Contents	**$11.0**
Agriculture	
Pears (700 acres)	**$ 4.2**
Wine grapes (400)	**$ 4.0**
Wild rice (500)	**$ 2.5**
Pasture	**$ 4.0**
Walnuts	**$ 0.6**
Other (500)	**$ 2.5**
TOTAL	**$58.8**

The cost of repairs is much less than the value of property protected.

Table 6 shows crop acreage, land value, a column of values which is 5 percent of land values, an estimate of net return over variable costs for each crop where available, and total cost per acre used to determine damages at the design flood. The damage cost per acre exceeds 5 percent of the value of land for pears, wine grapes, and walnuts. For pears, it was assumed that one year of net returns were lost. For wine grapes and walnuts, average damages from the 1997 floods for these crops as reported by CDFA were used. The costs per acre used in the analysis do not exceed net returns for any crop for which net return estimates were available. Damages per acre for tree crops can exceed net returns when trees are damaged or lost.

TABLE 6
MIDDLE CREEK CROPS, ACREAGE, LAND VALUE PER ACRE, 5 PERCENT OF LAND VALUE, NET RETURN, AND BENEFIT PER ACRE USED IN THE BENEFITS ANALYSIS

CROP	ACRES	LAND VALUE/ ACRE	VALUE TIMES 5%	NET RETURN	TOTAL BENEFIT/ ACRE
Pears	**700**	**$ 6,000**	**$300**	**$ 608**	**$ 608**
Wine Grapes	**400**	**$10,000**	**$500**	**$2,258**	**$ 832**
Wild Rice	**500**	**$ 5,000**	**$250**	**$ 522**	**$ 50**
Pasture	**800**	**$ 5,000**	**$250**	**$ 286**	**$ 50**
Walnuts	**100**	**$ 6,000**	**$300**		**$2,025**
Other	**500**	**$ 5,000**	**$250**		**$ 50**
TOTAL	**3,000**				

APPENDIX – NON-STRUCTURAL

A. IWR 88-R-2
Flood Damage Reduction

B. ER 1105-2-100
Project Development Guidance

C. Section 219 of WRDA 1999
Implementation Guidance

US Army Corps
of Engineers
Water Resources Support Center
Institute for Water Resources

NATIONAL ECONOMIC DEVELOPMENT PROCEDURES MANUAL-

URBAN FLOOD DAMAGE

MARCH 1988

IWR REPORT 88-R-2

CHAPTER IX

CALCULATION OF INUNDATION REDUCTION BENEFITS FOR NONSTRUCTURAL MEASURES

Nonstructural measures generally have negligible effect on any hydrologic or hydraulic relationships. Nonstructural measures primarily modify the stage or elevation-damage relationship. The exceptions to this rule are the usually minor and localized effects of floodproofing by use of landfill and relocation of structures from the floodway. The consequences of each type of nonstructural measure on the elevation-damage relationship and the procedure for measuring the subsequent benefits are described below.

FLOOD WARNING AND RESPONSE

Flood warning and preparedness systems improve a community's capability for accurate and timely forecasts of damaging floods. They provide for the communications channels, information, and resources necessary for individuals to safely evacuate, and for floodplain occupants to take effective damage reduction actions. Warning and preparedness systems incorporate six essential elements:

1) Monitoring is done by a radar system for early detection of weather patterns, and rain and stream gauges that monitor the magnitude and effect of storms.

2) Forecasts for the location, magnitude, and time of flood crests are calculated after entering the gage information into flood forecast models.

3) Warnings are given to floodplain occupants and flood fighting teams to take emergency actions.

4) Damage prevention actions include moving building contents and vehicles, shutting off and disconnecting equipment, rescheduling business operations, sealing entrances, and installing temporary barriers.

5) Evacuation is the process of facilitating orderly, safe movement of floodplain occupants from areas where there is the potential risk of physical harm.

6) Finally, there is the continual management of the warning and preparedness system to maintain the physical integrity of the monitoring and warning equipment, to insure the timeliness of the forecasting model, and to maintain the public awareness of the flood threat, warning messages and channels, and what actions to take in the event of an emergency.

The greatest potential lead time is limited, regardless of the forecasting equipment, by the size of basin, topography of the basin, the source of flooding, and the magnitude of flooding. Without the ability to forecast the amount and location of precipitation before it hits the ground, the forecast lead time is limited by the time of concentration, the amount of time in between when precipitation hits the ground and when it reaches the area with the potential flood hazard. Figure IX-1 shows how inundation lead time will vary with the frequency of the flood event.

The benefits of a flood warning and preparedness system depend on the extent and quality of investment made in all of the elements listed above. These benefits are measured by the incremental level of damages and cost prevented by a new system over and above what is already provided by the National Weather Service and community flood warning service programs.

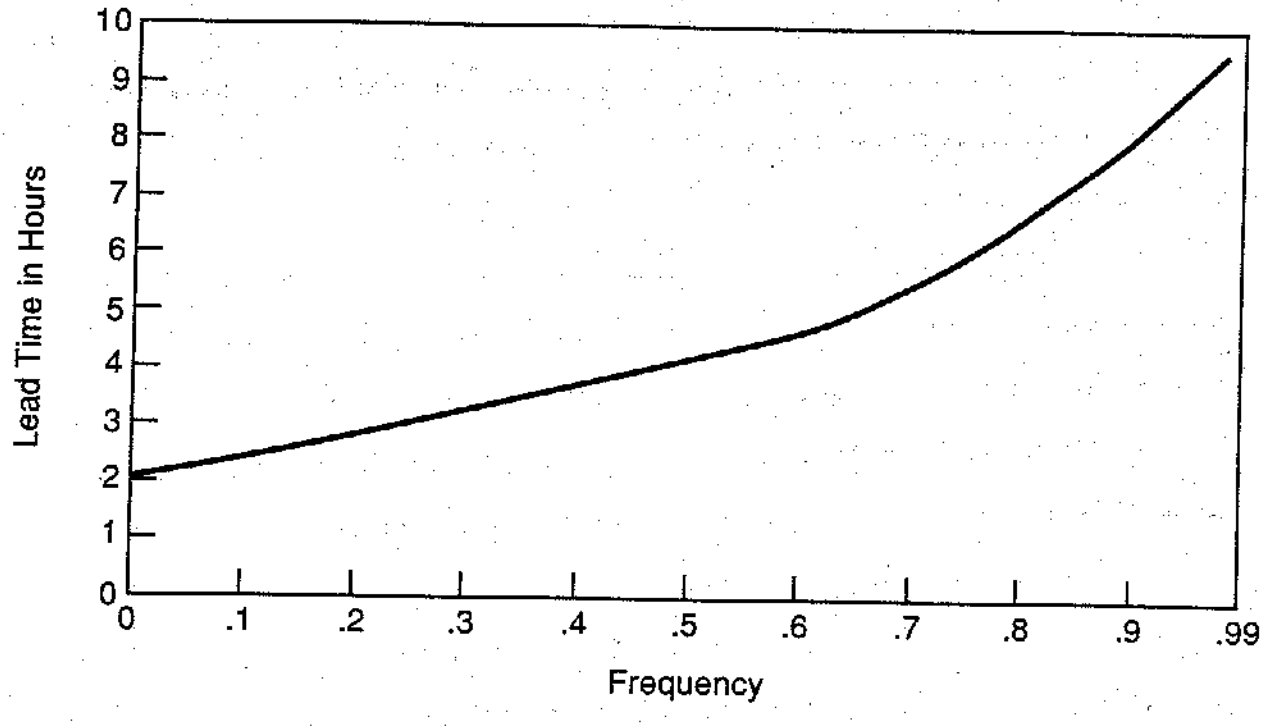

FIGURE IX-1 FREQUENCY - LEAD TIME

The benefits of warning systems depend on the following: 1) the accuracy and timeliness of the forecasts; 2) timeliness, informativeness, coverage, and credibility of the warning message; 3) the reliability of the forecast system to consistently give accurate site-specific, and timely flood predictions; and, 4) the degree and the effectiveness of the response by individuals, businesses, and local governments. Since much of benefits may not be realized without each part of the system operating, and there is a great deal of uncertainty involved in how well each of these components will operate, the benefits of warning are very difficult to evaluate. There is no specific degree of protection below which residual damages are curtailed. Instead, judgments must be made as to how well each of these systems will operate. Other significant problems are the lack of a track record in performing benefit/cost analysis and the even more significant lack of post-flood study to see how well flood warning and preparedness systems have performed.

Benefit calculations for warning and preparedness, when they have been made, generally are limited to physical inundation reduction benefits. This is primarily because of the lack of case studies that would help determine the effect of warning systems on non-physical cost, location, or intensification benefits.

A basic tool for evaluating benefits of warning and preparedness measures is the lead time-damages prevented function. This function was developed by Harold Day, and has been used by researchers ever since to determine the amount of damage that can physically be prevented within a given amount of time. The Day leadtime-damages prevented curve is illustrated in Figure IX-2. Day's curve assumed a 100% response, which

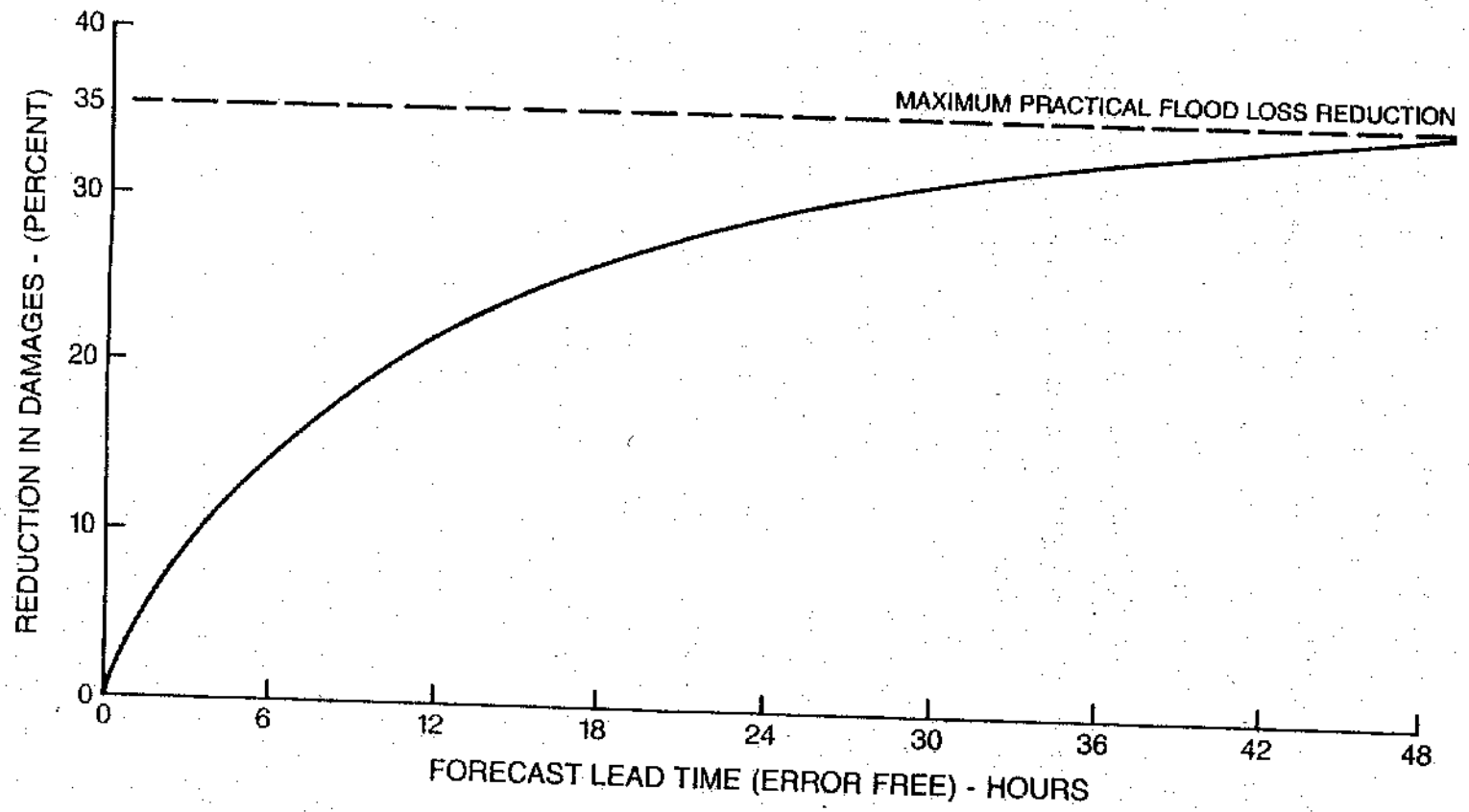

FIGURE IX-2 FLOOD WARNING RESPONSE MAXIMUM PRACTICAL FLOOD LOSS REDUCTION

presumes that all of the affected population will receive the message, know what to do, have the inclination and the capability to respond. (See Day, Harold. "Flood Warning Benefit Evaluation-Susquehanna River Basin" NOAA Tech Memo. WBTM HDRO-10, March, 1970.

The New York District's 1985 feasibility report Flood Emergency Preparedness System: Passaic River, New Jersey and New York, 1984, presented modification of the Day curve with more conservative assumptions on the extent of response. The degree and the effectiveness of the response were believed to depend on the means by which the message is received, with larger responses expected for a direct warning than a warning broadcast over the media.

The prevention of income losses was another benefit illustrated in Robert Kates' 1965 study of flood losses in the Lehigh Valley. Kates presented a business downtime function which showed that flood emergency costs, such as flood fighting, and police and fire custodial safety and traffic direction services, can be expected to increase as part of the costs of warning and preparedness. Efficiencies in delivering emergency service may occur with flood forecasting. The extent of these efficiencies have not been well documented.

Other non-physical costs, such as floodproofing, the administrative costs of flood insurance, temporary relocation, and land market value which cannot be expected to change substantially with warning and preparedness.

In areas subject to high velocity floods with limited lead time, public safety considerations may override the need for NED justification.

PERMANENT (DRY) FLOODPROOFING

Permanent or dry floodproofing includes actions taken in a dry, non-emergency period to reduce potential flood losses. Permanent floodproofing is generally identified with individual properties. Even measures normally thought of as structural, such as levees and floodwalls, are defined as floodproofing.

The measures described above under warning and preparedness are only activated in the case of imminent flooding. The floodproofing measures described here are permanent and usually require no action in the event of an emergency to make them operable. The measures have the obvious advantage of not being subject to a logistical constraint. Because of this advantage, floodplain activities can be assured of a more specific degree of protection and a consistent modification of the stage-damage function than what is found with warning and preparedness measures.

The degree of protection is, however, site specific. Floodproofing also leaves a high level of residual risk to individuals, because access to and from the structure may be blocked by floodwater and this will present a danger to individuals trying to enter or leave. There is also the threat that floodproofing may fail, causing as much or more damage than would have occurred without the floodproofing.

Permanent floodproofing devices can fall into three distinct categories:

1) Raising, which includes landfill, piers, and high foundations; 2) closures, which include non-porous construction material and permanent blockages; and, 3) barriers, which includes floodwalls and

levees. All of these categories include measures that can be applied to retrofitting existing structures or to new construction. Raising merely involves an adjustment in the building elevation in computing residual flood damage. There is the danger of structural failure to buildings elevated by piers during high velocity events. Benefits for closures can only be considered up to a point where hydrostatic pressure might causing problem. A particular building might only benefit from closures when flood levels are three feet or less above the first floor.

PERMANENT RELOCATION

Permanent relocation is the complete evacuation of existing activities to locations not susceptible to flood damage. Relocation may consist of 1) the physical movement of structures to new locations; 2) the demolition of structures at flood-prone locations and construction of new buildings at different locations; or, 3) the demolition of structures and provision of funds for purchase of new buildings. In all of these three cases, the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970 (P.L. 91-646) requires that the agencies implementing the relocation provide funds for moving and resettlement to displaced residents. It should be noted that any costs of relocation beyond the normal moving expences to satisfy the requirements of the Relocation Act are not normal NED costs.

Relocation has often been combined with other measures, particularly reservoirs and levees. Traditionally, relocation has served to facilitate

other measures by clearing land for construction. Only in recent years has relocation served as a damage reduction feature in its own right.

Permanent relocation consists of: 1) the purchase of all buildings and associated land within designated reaches and flood zones; 2) relocation assistance in the form of direct grants to individuals for their resettlement costs; and, 3) assistance to local government in planning for new uses for flood-prone property.

Relocation projects, like other nonstructural measures, generally have a negligible effect on the stage-discharge relationship. However, there can be a significant drop in stage on small streams for high levels of discharge when structures are removed from the floodway and the flow is unrestricted.

A 1985 review of Corps' experience found permanent relocation has had limited use as the primary project component. It has been most successful when combined with other mitigation measures, and for areas with severe and repeated flood damage, within the 25-year floodplain (Moser, 1985).

Relocation is the only measure where the residual damages for the affected activity can be assumed to be zero for all levels of flooding.

Benefits from permanent relocation can be classified into five categories: 1) the value for the new use of the vacated land; 2) reduction in damage to public property, such as roads and utilities; 3) reduction in emergency costs; 4) reduction in the administrative costs of disaster relief; and, 5) reduction in the flood insurance subsidy. The first category represents the location benefit. The other four categories represent benefits from the reduction in the publicly borne costs of flooding.

There is no benefit taken for reduction in private flood damage because it is assumed that expected flood losses are, for the most part, reflected in lower property values. So, because the reduced property values lower the costs of relocation, it would be double-counting to also consider the costs of the physical damages.

The location benefit is critical to the economic justification of a relocation project. It is unlikely that a relocation project can be justified if the evacuated property does not have considerable value in its new use. The location benefit is measured by the value of the floodplain in its new use. Unlike location benefits for structural projects, the value of the property in its old use is not subtracted because that value has already been considered in the purchase price of the relocated property.

The location benefits for agricultural or other income-producing activities can be determined by estimating the net income of the projected activity. An example of the net income approach to location benefits is given in the section on location benefit in Chapter X. Location benefits can also be determined by the hedonic price and contingent value approaches illustrated below.

The hedonic price procedure measures the internalized value of nonmarketable attributes. An example of this approach would be determining the value of open space land by comparing the market value of adjacent property to comparable property without the open space land nearby. The difficulty with this approach is finding "comparable" property with buildings and lots of similar size, condition, accessibility, character, and availability of community services.

The public damage reduction considered in the calculation of permanent relocation benefits includes reduction in damages to streets, sewers, water supply lines, lighting, electrical transmission lines, gas lines, and public vehicles. Details of estimating the damage to these facilities are found in Appendix A. Care should be taken to consider any residual costs to transportation facilities and utilities that would remain to service areas outside the floodplain or any new activity that moves in as a result of the relocation.

Emergency flood costs, including the administrative costs of disaster relief, can be measured by the procedures described in Chapter VII. Permanent relocation would have the following implications to the emergency costs listed in Chapter VII: it can be assumed that flood forecasting costs could not be substantially reduced, because they are generally applied to a much larger area than would be affected by a relocation. Warning, temporary evacuation, flood fighting, reoccupation costs, and administrative costs of disaster relief could be virtually eliminated, depending on the new use of the evacuated floodplain. The magnitude of emergency costs should be estimated for various land uses and frequencies of flooding. The benefit will be the difference in expected costs with and without the relocation project.

Unlike structural projects, permanent relocation is concerned with the reduction in the flood insurance subsidy, rather than just the elimination of the administrative costs of flood insurance. This subsidy, like the emergency costs mentioned above, will cause distortions in the market value of land. The market value is distorted upward because the subsidies reduce the out-of-pocket costs to the landowners and renters.

The flood insurance subsidy is determined by deducting the average annual insurance premium from the average annual expected insured loss and the administrative costs of flood insurance. The insured loss assumes coverage of all physical costs including damage to the building structure, damage to contents, and cleanup of the structure and contents. It excludes damages to certain contents, such as paintings or antiques, damage to outside property, and requires a $500 deductible per loss for structure and contents. An example of the flood insurance subsidy benefit for a single residence is given below:

Table IX-1

Flood Insurance Subsidy Calculation

Item	Amount
House Value	$15,000
Contents Value	8,000
Agency Cost	
Average Annual Damages	1,450
Agent Fee (15% of the premium)	15
Other Administrative Costs	20
Total	$1,485
Policy-Holder's Cost	
Annual Insurance Premium ($.40/$100 of structure value and $.50/$100 of contents)	100
Annual Uninsured Damage	150
Annual Expected Deductible	300
Total	$550
Average Annual Flood Insurance Subsidy	$ 935

An additional subsidy which can distort the value of floodplain property is the tax savings from casualty claims on Federal and state income tax forms for individual taxpayers. The magnitude of the casualty deduction is limited to uninsured and otherwise uncompensated losses. Only the portion of uncompensated loss that exceeds 10 percent of the taxpayer's adjusted gross income is deductible. Even insured properties will still have uninsured losses on deductibles and types of losses excluded from coverage.

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PLANNING GUIDANCE NOTEBOOK

22 APRIL 2000

SECTION III - Flood Damage Reduction

E-16. Federal Interest. The Flood Control Act of 1936 established the policy that flood control on navigable waters or their tributaries is in the interest of the general public welfare, and is therefore a proper activity of the Federal Government. It provided that the Federal Government, cooperating with state and local entities, may improve streams or participate in improvements "for flood control purposes, if the benefits to whomsoever they may accrue are in excess of the estimated costs, and if the lives and social security of people are otherwise adversely affected." The 1936 Act, as amended, and more recently the Water Resources Development Act of 1986 and other acts, specify the details of Federal participation.

E-17. Types of Improvements.

a. Structural Measures. These include dams with reservoirs, dry dams, channelization measures, levees, walls, diversion channels, ice-control structures, and bridge modifications.

b. Nonstructural Measures. Section 73 of the 1974 Water Resources Development Act requires consideration of nonstructural alternatives in flood damage reduction studies. They can be considered independently or in combination with structural measures. Nonstructural measures reduce flood damages without significantly altering the nature or extent of flooding. They do this by changing the use made of the flood plains, or by accommodating existing uses to the flood hazard. Examples are flood proofing, relocation of structures, flood warning/preparedness systems, and regulation of flood plain uses.

(1) Permanent Relocation/Evacuation Plans. These plans provide for permanent evacuation and relocation/demolition of flood plain structures. There are no damages avoided claimable as benefits for the properties which are relocated or evacuated. Benefits accrue in four ways: a) the value of new use of the vacated land; b) reduction in damage to public property, such as roads and utilities; c) reduction in emergency costs; and d) reduction in the administrative costs of the National Flood Insurance Program and disaster relief. Benefits from future use of the vacated flood plain (usually recreation) will generally be the dominant NED benefit. Non-monetary benefits accruing from ecosystem restoration may also be considered. For evacuation plans that are clearly formulated for flood damage reduction there is no limitation on the amount of recreation benefits, as may exist for structural projects. Thus for these plans the recreation benefits may exceed 50 percent of the benefits needed for justification. Separable costs for improvements necessary to achieve ecosystem and or recreation benefits are cost shared in accordance with specific cost-sharing provisions for those purposes.

(2) With Project Land Use and Benefit Evaluation for Nonstructural Projects. The central fact about nonstructural projects, changes in land use, has several important implications. First, eliminating the existing land uses eliminates all services previously provided in the area, not just the flood damages. That is, all housing services, all retailing or commercial services and all other services provided by the removed structures (and associated activities) will also be eliminated. Second, in most cases, most of the benefits for the nonstructural project will be associated with new uses of the vacated land, yet frequently little effort is devoted to forecasting and evaluating the new land uses. Recreational and environmental uses will be the most common post-project uses. If non structural projects are to be justified, plans for the post-project land use will generally be needed. In other words, just simply stating that post-project land use will be "open space" will not be sufficient to support the benefits of the nonstructural projects. Third, land use changes will have spillover effects, that is, they can affect nearby property values. Most frequently, spillover effects are negative and are used to justify zoning changes, but spillover effects for nonstructural projects will be, in all likelihood, positive and the task is therefore not to prevent them through zoning but to estimate their magnitude through analysis.

(3) Flood Proofing Measures. These are modifications of structures to minimize flood damages by such methods as elevating buildings, sealing walls, closing off openings, protecting plumbing and utilities and installing pumps and valves. Corps participation in flood proofing plans is permitted as long as they address two or more structures.

(4) Flood Warning Systems.

(a) The typical flood warning system consists of methods for determining the flood threat, methods for disseminating the flood warning, and a preparedness plan detailing the response to that warning. The Corps involvement in development of methods for determining the flood threat and disseminating the warning can include selection, siting, installation, and calibration of gages and other equipment to collect, evaluate and disseminate pertinent data. In addition, the Corps can provide assistance and guidance to ensure that the preparedness plan is adequate and will provide the necessary response to minimize the possibility of loss of life, and to reduce damages. This includes coordinating with local officials, providing technical advice and planning guidance, and developing adequate mapping to identify flood threatened areas, evacuation routes, temporary shelters, etc.

(b) A flood warning system can be recommended as a stand-alone project, or as a component of a more complex, flood damage reduction plan. For example flood warning could be combined with levee closing devices or with a channel modification. In addition, a flood warning system can be proposed as an interim measure until other structural or non-structural measures can be implemented.

(5) Regulation of Flood Plain Uses. Adoption and enforcement of regulations for flood plain management are entirely a local responsibility. However, the Corps can provide technical assistance and planning guidance in conjunction with a flood control project. Also, flood plain management planning assistance is continuously available through the Corps Flood Plain Management Services Program.

E-19. NED Benefit Evaluation Procedures: Urban Flood Damage

a. Purpose. This section presents the procedure for measuring the beneficial contributions to national economic development (NED) associated with the urban flood hazard reduction features of water resource plans and projects.

b. Conceptual Basis.

(1) General. Benefits from plans for reducing flood hazards accrue primarily through the reduction in actual or potential damages associated with land use.

(2) Benefit Categories. While there is only one benefit standard, there are three benefit categories, reflecting three different responses to a flood hazard reduction plan.

(a) Inundation Reduction Benefit. If floodplain use is the same with and without the plan, the benefit is the increased net income generated by that use. If an activity is removed from the floodplain, this benefit is realized only to the extent that removal of the activity increases the net income of other activities in the economy. Engineering Regulation 1105-2-101, Risk-Based Analysis for Evaluation of Hydrology/Hydraulic and Economics in Flood Damage Reduction Studies, requires risk-based analysis in all flood-damage reduction studies. The regulation and the complementary Engineering Manual 1110-2-1619 provide the evaluation framework to be used in these studies. The regulation identifies key variables that must be explicitly incorporated into the risk-based analysis. At a minimum, the stage-damage function for economic studies

(with special emphasis in structure first floor elevation, and content and structure values for urban studies); discharge associated with exceedence frequency for hydrologic studies; and conveyance roughness and cross-section geometry for hydraulic studies must be incorporated in the risk-based analysis. The ER further requires a probabilistic display of benefits and eliminates freeboard to account for hydraulic uncertainty.

(b) Intensification Benefit. If the type of floodplain use is unchanged but the method of operation is modified because of the plan, the benefit is the increased net income generated by the floodplain activity.

(c) Location Benefit. If an activity is added to the floodplain because of a plan, the benefit is the difference between aggregate net incomes (including economic rent) in the economically affected area with and without the plan

(3) Types of Flood Damage. Flood damages are classified as physical damages or losses, income losses, and emergency costs. Each activity affected by a flood experiences losses in one or more of these classes.

(a) Physical Damages. Physical damages include damages to or total loss of buildings or parts of buildings; loss of contents, including furnishings, equipment, [motor vehicles,] decorations, raw materials, materials in process, and completed products; loss of roads, sewers, bridges, power lines, etc.

(b) Income Loss. Loss of wages or net profits to business over and above physical flood damages usually results from a disruption of normal activities. Estimates of this loss must be derived from specific independent economic data for the interests and properties affected. Prevention of income loss results in a contribution to national economic development only to the extent that such loss cannot be compensated for by postponement of an activity or transfer of the activity to other establishments.

(c) Emergency Costs. Emergency costs include those expenses resulting from a flood what would not otherwise be incurred, such as the costs of evacuation and reoccupation, flood fighting, cleanup including hazardous and toxic waste cleanup, and disaster relief; increased costs of normal operations during the flood; and increased costs of police, fire, or military patrol. Emergency costs should be determined by specific survey or research and should not be estimated by applying arbitrary percentages to the physical damage estimates.

c. Planning Setting.

(1) General. The benefit of flood hazard reduction plans is determined by comparison of the with and without project conditions.

(2) Without Project Condition. The without project condition is the land use and related conditions likely to occur under existing improvements, laws, and policies. There are three significant assumptions inherent to this definition:

(a) Existing and authorized plans. Existing flood hazard reduction plans are considered to be in place, with careful consideration given to the actual remaining economic life of existing structures. Flood hazard plans authorized for implementation but not yet constructed are evaluated according to the relative likelihood of actual construction. If there is a high likelihood of construction, the authorized plan is considered to be in place.

(b) Flood Disaster Protection Act. The adoption and enforcement of land use regulations pursuant to the Flood Disaster Protection Act of 1973 (Public Law 93-234) is assumed.

(1) Regulation certified or near certification. If the local land use regulation has been or will be certified, partially waived, or adjusted by the Flood Insurance Administration (FIA) as adequate under 24 CFR 1910.3(c) and/or (d) and 24 CFR 1910.5, that regulation defines the without project condition.

(2) Regulation not yet certified. It is assumed that the local jurisdiction will adopt in the near future land use regulations certifiable to FIA under the without project condition as a datum and under the with project condition if a residual hazard will remain. This applies to floodplains regulated under 24 CFR 1910.3(a) and (b); to floodplains regulated by local ordinances independent of FIA; and to floodplains with no flood regulation in effect. For riverine situations, the following two crucial features are included: no future confinement or obstruction of the regulatory floodway; and no future occupancy of the flood fringe unless residences are elevated to or above 100-year (.01 annual probability) flood level and nonresidential buildings are flood proofed to that level.

(3) Application. It is assumed that flood proofing costs will be incurred if an activity decides to locate in the floodplain.

(4) Executive Orders. Compliance with E.O. 11988, Floodplain Management and E.O. 11990, Protection of Wetlands, is assumed.

(5) Individual actions. In addition to the three assumptions stated above, the analyst shall consider the likelihood that individuals will undertake certain flood hazard reduction

measures, such as flood proofing, when the cost of such measures is reasonable compared to the costs of potential flood damages.

(3) With Project Condition. The with project condition is the most likely condition expected to exist in the future if a specific project is undertaken. There are as many with project conditions as there are alternative projects.

(a) In projecting a with project condition, the analyst must be sensitive to the relationship between land use and the characteristics of the flood hazard for the alternative project being analyzed.

(b) The same assumptions underlie the with project condition and without project conditions.

(c) Consideration should be given to both structural and nonstructural alternatives and to alternatives incorporating a mix of structural and nonstructural measures. Non structural measures include:

(1) Reducing susceptibility to flood damage by land use regulations, redevelopment and relocation policies, disaster preparedness, flood proofing, flood forecasting and warning systems, floodplain information, floodplain acquisition and easements; and

(2) On-site detention of flood waters by protection of natural storage areas such as wetlands or in manmade areas such as building roofs and parking lots.

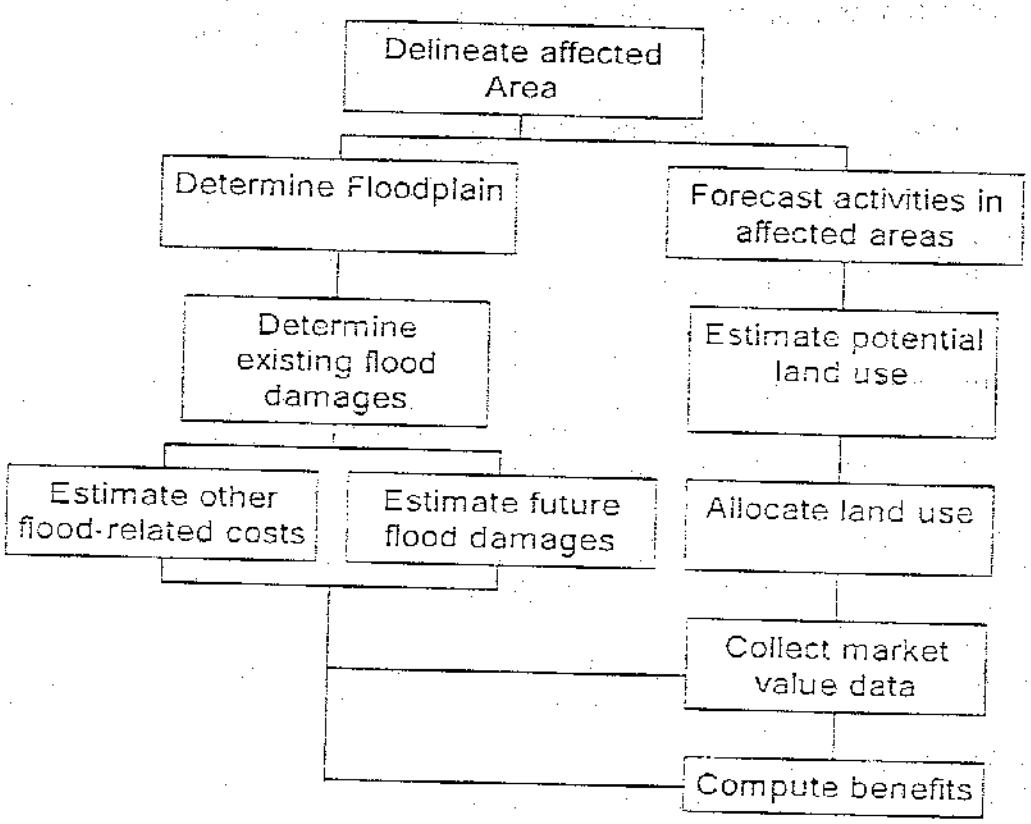
(3) Since project alternatives can differ in their physical characteristics, the optimal timing of projects and of individual project features should be considered in project formulation.

commercial. If the potential use of the floodplain includes industrial use within a standard metropolitan statistical area (SMSA) (now called metropolitan statistical area (MSA)), the entire SMSA (MSA) is the affected area; for residential use, even within an SMSA (MSA), a much smaller area may be designated the affected area.

d. Evaluation Procedure: General. Ten steps are involved in computing benefits (see Figure E-4). The steps are designed primarily to determine land use and to relate use to the flood hazard from a NED perspective. The level of effort expended on each step depends on the nature of the proposed improvement and on the sensitivity of the project formulation and justification to further refinement. The first five steps result in a determination of future land use; emphasis is on the overall reasonableness of local land use plans with respect to OBERS (OBERS no longer exist, but population, income and economic projections can still be obtained from the U.S.

Department of Commerce, Bureau of Economic Analysis) and other larger area data, and to recognition of the flood hazard.

Figure E- 4 Urban Flood Damage Benefit Evaluation Procedure



e. Step 1--Delineate Affected Area. The area affected by a proposed plan consists of the floodplain plus all other nearby areas likely to serve as alternatives sites for any major type of activity that might use the floodplain if it were protected.

f. Step 2--Determine Floodplain Characteristics. The existing characteristics of the floodplain must be determined before its actual use can be estimated; therefore, undertake an inventory of the floodplain to determine those characteristics that make it attractive or unattractive for the land use demands established in steps 3 and 4, with emphasis on those characteristics that distinguish the floodplain from other portions of the affected area. Use the following categorizations as a guide:

(1) Inherent Characteristics of a Floodplain. Floodplain characteristics may include:

(a) Flooding. Describe the flood situation, including a designation of high hazard areas. The description should include characteristics of the flooding, such as depths, velocity, duration, and debris content; area flooded by floods of selected frequencies, including 100-year frequency [.01 annual probability]; historical floods, and, where applicable, larger floods. [Description of flood characteristics for a given frequency or discharge should be based on the median probability discharge. The regulatory floodplain as defined by the National Flood Insurance Program will always be described.]

(b) Floodway, Natural Storage. Describe and delineate those areas which, if urbanized or structurally protected, would affect natural storage, velocity, or stage, or would affect flood flows elsewhere.

(c) Natural and Beneficial Values. Many floodplains, particularly those near urban areas, are potential sites for recreation, open space, wetland, or wildlife preserves. This potential should be recognized and presented.

(d) Transportation. Floodplains near navigable streams have inherent attractiveness for industries that demand water-oriented transportation. Floodplains also serve as sites for railroads, highways, pipelines, and related facilities that are not susceptible to serious flood damage but have a tendency to attract industry to the area. [Flood damage to transportation systems and the resulting transportation delay costs may be an important damage category in many urban settings. Care should be taken to adequately address transportation delay costs in both the without and with project condition.]

(e) Other Attributes. Other inherent attributes of floodplains may include soil fertility, reliability of water supply, waste disposal, and sand, mineral, and gravel deposits.

(2) Physical Characteristics. Describe pertinent physical characteristics, including slope, soil types, and water table.

(3) Available Services. Most activities require some or all of the following services: transportation (highway and rail), power, sewerage, water, labor, and access to markets. Indicate the availability of such services in or near the floodplain, including comparisons with similar services available in other portions of the affected area.

(4) Existing Activities. Include in the inventory of the floodplain a list of existing activity types, the number of acres, and the density, age, and the value of structure of each activity-type by flood hazard zone.

g. Step 3--Project Activities in Affected Areas. Base economic and demographic projections on the most recent available studies and include the following: population, personal income, recreation demand, and manufacturing, employment, and output. Additional projections may be necessary for any given area, depending on the potential uses of these projections. Base projections on assessment of trends in larger areas and appropriate data (e.g., OBERS) [Bureau of Economic Analysis]; the relationship of historical data for the affected area to trends projected for larger areas; and consultation with knowledgeable local officials, planners, and others. The basis for the projections should be clearly specified in the report. [Estimates of future growth benefits shall be based on current unbiased economic growth indices. Whenever possible the growth indices should be independent estimates. Paragraph E-19c. requires that for the without project condition, floodplain communities will be assumed to belong to the National Flood Insurance Program (NFIP), administered by the Federal Emergency Management Agency. In order to participate in this program, the local community must preclude new development in the regulatory floodway as defined by the community, and require that new development in the NFIP regulatory floodplain outside of the floodway be constructed with first floor elevations at or above the .01 annual probability 100-year elevation. Therefore, future development will be assumed to be protected to the .01 probability 100-year discharge at the end of the period of analysis. The .01 probability discharge and elevation will be determined by the Corps consistent with levee certification guidance. If individual communities have floodplain restrictions more stringent than NFIP criteria, projections of future development should reflect the local criteria. However, under no circumstances, will future development be assumed in any area subject to flooding in the present and future median .01 probability flood.]

h. Step 4--Estimate Potential Land Use. Estimate potential land use within the affected area by converting demographic projections to acres. The conversion factors can normally be derived from published secondary sources, from agency studies of similar areas, or from empirical and secondary data available in the affected area. The categories of potential land use

need be only as detailed as necessary to reflect the incidence of the flood hazard and to establish the benefits derived from a plan.

i. Step 5--Project Land Use. Allocate land use demand to floodplain and non floodplain lands for the without project condition and for each alternative floodplain management plan.

(1) Basic Factors. Base the allocation on a comparison of the floodplain characteristics, the characteristics sought by potential occupants, and availability of sought-after characteristics in the non floodplain portions of the affected area.

(2) Criteria. The floodplain should not be used unless it has characteristics that give it a significant economic advantage to the potential user over all other available sites within the affected area. If such advantages exist, determine whether they overcome potential flood losses, potential flood proofing costs, and the costs of other related hazards. Flood losses and costs should be specific to the zone of the floodplain being considered.

j. Step 6--Determine Existing Flood Damages. Existing flood damages are the potential average annual dollar damages to activities affected by flooding at the time of the study. Existing damages are those expressed for a given magnitude of flooding or computed in the damage frequency process. No projection is involved. The basis for the determination of existing damages is losses actually sustained in historical floods; therefore, specify the year and month of all significant recorded discharges above zero point of damage and indicated the damages actually sustained by reach or zone and type of property and activity. Historical data are often incomplete; urbanization and other changes will have occurred over the years. Many streams and reaches do not have gaging stations. Therefore, data on historical flood losses should be carefully scrutinized and supplemented by appraisals, use of area depth-damage curves, and an inventory of capital investment within the floodplain. Further, estimates of damages under existing conditions should be computed for floods of magnitude that have not historically occurred. Estimate average annual losses by using standard damage-frequency integration techniques and computer programs that relate hydrologic flood variables such as discharge and stage to damages and to the probability of occurrence of such variables. Annual hydrologic data are normally sufficient for urban drainage estimates. Access flood damages by activity type and by whether they are borne by the owner or by the public at large.

k. Step 7--Project Future Flood Damages. Future flood damages are the dollar damages to economic activities identified in step 3 that might use the floodplain in the future in the absence of a plan. Use this step in combination with step 5 (land use) to determine land use and associated damages for each future with project and without project condition. "Future" is any time period after the year in which the study is completed; in order to relate costs ultimately to benefits, however, future damages must be discounted to the base year. Determine future flood

damages on the basis of losses sustained both by the floodplain occupant and by others though insurance subsidies, tax deductions for casualty losses, disaster relief, etc.

(1) Hydrologic Changes. Changes in basin land use may result in major alteration of drainage characteristics, particularly surface runoff; project such hydrologic changes for the planning period. Average future hydrologic conditions should not be used, since they obscure situations in which the level of protection afforded by a project may be significantly different from average conditions by the end of the planning period.

(2) Economic Changes. Economic changes can be expected to result in a change in the level of future flood losses. A benefit-cost ratio for the existing condition should always be shown. If the ratio is greater than 1:1, the projection of future benefits may be accomplished in abbreviated form unless it would distort the comparison of alternative projects or the cost allocation and cost sharing in multipurpose projects. In the latter situation, the detail and accuracy of the estimates of flood control benefits should be comparable to the estimates of benefits for other water resources purposes.

(3) Projection of Physical Damages. Base measurement and projection of flood damages on the establishment of actual, observed relationships between damages, flood characteristics, and those indicators used for measurement and projection. These relationships should be modified as appropriate by consideration of constraints that change the historically derived relationship between flood damages and a given indicator. The relationships should be made explicit in the report and their accuracy and representativeness supported, to the extent possible, by empirical evidence. Use three steps in measuring flood damages for a future year: estimate the number and size of physical units; estimate the future value of units; and determine the damage susceptibility of units.

(a) Physical Units. The first step in measuring flood damages for a future year is to determine from step 2 (paragraph E-19f.) the number and size of physical units with potential to use the floodplain by hazard zones for each activity type. Care must be taken to determine whether existing structures will continue to occupy the floodplain over the period of analysis and, if not, the future land use and damage potential of new structures.

(b) Value per Physical Unit. This step involves estimating future unit value. Increases in the value of property in the floodplain may result from the expansion of existing facilities or the construction of new units. The following guidance applying to content value is derived from an empirical study of flood-prone property.

(1) Existing development. Use the OBERS [Bureau of Economic Analysis] regional growth rate for per capita income as the basis for increasing the real value of residential contents in the future.

(2) Future development. Project the value of contents within new residential structures from the year each unit is added.

(3) Translation to future flood damages. Use the projected rate of increase in the value of flood-susceptible household contents as the basis for increasing the future unit flood damage to household contents.

(4) Limit. The value of contents should not exceed 75 percent of the structural value of the residence unless an empirical study proves that a special case exists (e.g., trailer parks), nor should the increase in value of household contents be projected beyond project year 50. [Current guidance on content-to-structure ratios is provided in paragraph E-19q.]

(5) Commercial and industrial property. The procedure described for residential contents does not apply to commercial and industrial categories.

(c) Damage susceptibility. The third step in measuring future flood damages is to determine the damage susceptibility of units. Once the number of physical units and the value associated with each unit are known, examine possible future changes, if any, in damage susceptibility relationships as a function of the total value of each physical unit and the stream's flood characteristics, such as velocity, depth, duration, volume, debris load, and salinity. Some of the determinants of damage susceptibility are type of activity, vertical development, location within the floodplain, nature of flood proofing, construction material used, and individual response.

(1) Projection of Income Losses. Income losses may be projected to increase on the basis of projected land use. Increases in physical losses should not be used to project income losses.

(2) Projection of Emergency Costs. Emergency costs encompass a wide variety of programs. Some, such as emergency shelter and food, are primarily a function of occupancy of the floodplain but not of the value of development in the floodplain. Emergency costs should not be projected to increase as a direct function of physical losses.

(4) Use of Assessed Value Real Estate Appraisal and Market Value Data in Flood Damage Reduction Studies. Flooding causes physical damages to structures. In the past the Corps frequently estimated damages and cost of repair directly. The Corps now uses a risk-based procedure as defined by ER 1105-2-101. This procedure requires the use of depth-damage

curves, which express an average relationship between depth of flooding and damages. Damages are expressed as a percentage of structure value. When depth-damage curves are used, the correct measure of structure value, consistent with cost-benefit concepts, is replacement cost less depreciation to the existing (pre-flood) structure.

(a) Replacement cost is the cost of physically replacing (reconstructing) the structure (only). Depreciation accounts for deterioration occurring prior to flooding, and variation in remaining useful life of structures.

(b) Assessed value, real estate appraisal and market value data do not necessarily provide acceptable and directly useable estimates of replacement cost less depreciation, even when separate land and improvement values are reported. A variety of particular causes may make the data inappropriate, but the fundamental reason is that these data are produced for and primarily used for purposes other than estimation of flood damages, that is for other than NED benefit estimation purposes.

(c) Such data has some advantages for Corps planners as it is generally available and can be relatively inexpensive. Furthermore, in many cases such data may be useable, either directly or as modified. The appropriateness of the data must be verified however.

(d) When real estate appraisals are used as a source of basic data, the appraisal process shall be documented.

(e) Requirement. When structure value data is obtained from sources other than direct estimation of cost of physical replacement less depreciation, these data shall be verified as being reasonable estimates of replacement cost less depreciation. This can be done using a sampling procedure to select a relatively small number of structures for direct estimation of replacement cost less depreciation. The results can be used to compare to, and if appropriate, adjust the data obtained from other sources.

l. Step 8--Determine Other Costs of Using the Floodplain. The impact of flooding on existing and potential future occupants is not limited to flood losses. Some of the impacts are intangible but others can be translated into NED losses. These latter include the following:

(1) Flood Proofing Costs. High flood hazards lead to high flood costs. Therefore, compute the flood proofing costs of different activity-types and different flood hazard zones.

(2) National Flood Insurance Costs. A national cost of the flood insurance program is its administration. The cost of servicing flood insurance policies in effect at the time of the study is the average cost per policy, including agent commission, and the costs of servicing and claims adjusting. FIA should be contacted to obtain these costs.

(3) Modified Use. In some cases, the flood hazard has caused structures to be used less efficiently than they would be with a project. For example, the first floor of garden apartments may not be rented because of a flood hazard, or property may be configured in a different way with the plan compared to without a plan.

m. Step 9--Collect Land Market Value and Related Data. If land use is different with and without the project, compute the difference in income for the land. This is generally accomplished by using land market value data. Provide supporting data in the situations described in the paragraphs below.

(1) Land Use is Different With Project. If land use is different with compared to without the project, collect the following data as appropriate to complete step 10.

(a) Comparable Value. If the plan does not result in a major addition to the supply of land in the area, the value with protection is the market value of comparable flood-free land. If the plan results in a major addition to the supply of land, the effect on the price of land should be taken into account in estimating the value of floodplain lands with protection. The flood-free land should be comparable in terms of physical and infrastructural characteristics.

(b) Existing Value. Use the value of nearby floodplain sites or, as appropriate, the current value of the floodplain. In either case, report the current and, if available, past market values of the floodplain. Use actual market values, not capitalized income values. Therefore, it should not be assumed that the value of land being used for agriculture in an urban or urbanizing situation is the capitalized value of agricultural returns or that any value higher than this is due to speculation that a Federal project will be constructed or lack of knowledge. On the contrary, without project land values in excess of agricultural land values should be expected, reflecting the probability of future use as well as existing and anticipated infrastructural investments.

(c) Net Income Data. The net income (earned) with a project may be estimated directly based on an analysis of a specific land use with the project. This approach would be used, for example, for lands to be developed for recreation: the projected recreation benefits would constitute the gross income earned on the floodplain and would be shown as a project benefit.

(d) Encumbered Title Market Value. Estimate the market value of land with an encumbered title for inclusion as a benefit in step 10 in situations in which the floodplain is to be evacuated, no specific public use is planned, and the land could be resold with an encumbered title (which would ensure that future uses would be consistent with Executive Order 11988, Floodplain Management, May 24, 1977).

(2) Land Use is Same But More Intense With Project. If land use is the same but more intense, as when an activity's use of the floodplain is modified as a result of the project, base determination of the increase in income on increased land values or direct computation of costs and revenues.

(3) Evacuation Plan. In the case of an evacuation plan, changes in market value of properties adjacent to a restored floodplain may reflect recreation or open-space benefits to occupants of those properties. Document such an NED benefit by empirical evidence. Care must be taken to avoid double counting of benefits.

(4) Market Value is Lowered by Flood Hazard. If the market value of existing structures and land is lower because of the flood hazard, restoration of the market value represents a quantification of otherwise intangible benefits. In such cases, the benefit is the difference between increased market value and that portion of increased market value attributable to reductions in flood damages. Careful attention should be given to ensuring that factors not related to the flood hazard are not included as project benefits.[1]

(5) No Projected Increase in Market Value. Projected increase in the market value of land over the project life with and without a plan should not be used to measure flood hazard reduction benefits because the current market value of land theoretically captures the expected stream of income over time.

n. Step 10--Compute NED Benefits. At this point in the analysis, enough information is available to compute NED benefits for structural and nonstructural measures. Table E-15 displays the types of benefits claimable for three of the major flood hazard reduction measures and the steps in the procedure that provide the necessary data. The table applies generally; specific cases may vary. Discount and analyze all benefits at the appropriate discount rate to the beginning of the period of analysis. Benefits are categorized in the following way:

(1) Inundation Reduction Benefits. To the extent that step 5 indicates that land use is the same with and without the project, the benefit is the difference in flood damages with and without the project (step 7), plus the reduction in flood proofing costs (step 8), plus the reduction in insurance overhead (step 8), plus the restoration of land values in certain circumstances (step 9). To the extent that step 5

Table E- 15 Guide to Types of Benefits

Type of Benefit (and step)	Structural	Floodproofing	Evacuation
Inundation:			
Incidental Flood damages (step 6)	Claimable.....	Claimable.....	Claimable.....
Primary Flood damages (step 6)	Claimable.....	Claimable.....	Not Claimable..
Floodproofing cost reduced (step 7)	Claimable.....	Not Claimable....	Not Claimable..
Reduction in Insurance overhead (step 7)	Claimable.....	Claimable.....	Claimable.....
Restoration of land value (step 9)	Claimable.....	Claimable.....	Not Claimable..
Intensification (steps 7 and 9)	Claimable.....	Claimable.....	Not Claimable..
Location:			
Difference in use (step 9)	Claimable.....	Claimable.....	Not Claimable..
New use (step 9)	Not Claimable.....	Not Claimable....	Claimable.....
Encumbered title (step 9)	Not Claimable.....	Not Claimable....	Claimable.....
Open space (step 9)	Not Claimable.....	Not Claimable....	Claimable.....

indicates a difference in land use for an evacuation plan, the benefit is the reduction in externalized costs of floodplain occupancy that are typically borne by taxpayers or firms providing services to floodplain activities. Examples of such costs are subsidized flood insurance; casualty income tax deductions; flood emergency costs; and flood damages to utility, transportation, and communication systems. Reduction of costs not borne by the floodplain activities may be a major benefit of projects to evacuate or relocate floodplain activities. Reduction of flood damages borne by floodplain activities should not be claimed as a benefit of evacuation or relocation because they are already accounted for in the fair market value of floodplain properties.

(a) All damages avoided by flood mitigation measures are beneficial effects. Evacuation and relocation projects provide a special case for economic analysis because the effect of damage reductions are present in measures of both benefit and cost, therefore, double counting of this

benefit must be carefully avoided. IWR Research Report 85-R-1, Assessment of the Economic Benefits from Flood Damage Mitigation by Relocation and Evacuation, provides a comprehensive discussion of NED benefit evaluation procedures for relocation and evacuation projects. In planning for, and evaluation of, relocation and evacuation projects considerable attention should be paid to the with project use of land which is to be evacuated, as the benefit associated with such use may be crucial to project feasibility.

(b) Benefit from Saving Insurance Costs. One category of costs that can be avoided by a removal plan is public compensation for private flood damages through the subsidized Federal Flood Insurance Program. Expressing savings in these externalized costs as project benefits is appropriate for properties in communities that participate in the Federal Flood Insurance Program or are expected to participate under the without project condition. This benefit is the reduction of insurable flood damages projected over the life of the project with careful attention to the projected without project condition.

(c) Insurable Flood Damages. Base the projection of insurable flood damages on traditional depth-damage-frequency relationships used in projecting total flood damages. Then reduce projected total damages by subtracting: Losses that are noninsurable either because they are in noninsurance loss categories or because they exceed the coverage limits of the subsidized program; the deductible portion of each expected flood damage event; and the annual cost of the insurance premium paid by the policyholders. For this benefit calculation, assume that all eligible parties purchase subsidized insurance. This assumption is appropriate because the market value of properties, which determines project costs, reflects the availability of the program, not the extent of its utilization by current floodplain occupants.

(2) Intensification Benefits. If step 5 indicates that land uses are the same with and without the project but activity is more intense with the project, measure the benefit as the increase in market value of land from step 9 or changes in direct income from step 6. Care must be taken to avoid double counting.

(3) Location Benefits. If step 5 indicates that land use is different with and without the project, measure the benefit by the change in the net income or market value of the floodplain land and certain adjacent land where, for example, the plan creates open space (step 9).

E-21. Federal and Non-Federal Participation. As a general rule, a PCA must be executed between Federal and non-Federal participants prior to advertising and award of the contract.

a. Structural Measures. The 1986 and 1996 Water Resources Development Acts modified the basic requirements for non-Federal participation in flood control projects. The requirements for structural projects are essentially as follows:

(1) Provide a cash contribution equal to 5 percent of structural flood control features costs.

(2) Provide all lands, easements, rights-of-way, relocations (except existing railroad bridges and approaches thereto) and suitable borrow and dredged material disposal areas (referred to as LERRD).

(3) If the sum of the above two items is less than 35 percent of the costs assigned to flood control, non-Federal sponsors will pay the difference in cash. If it is greater than 35 percent, total non-Federal costs shall not exceed 50 percent of total project costs assigned to flood control. Contributions in excess of 50 percent will be reimbursed by the Federal Government to the non-Federal sponsor. Total contributions in excess of 30 percent may be reimbursed to the Federal government over a period not to exceed 15 years.

(4) Operate, maintain, repair, replace and rehabilitate the project after completion without cost to the United States in accordance with regulations prescribed by the Secretary of the Army.

(5) Hold and save the United States free from damages due to the construction or subsequent operation and maintenance of the project, except those damages due to the fault or negligence of the United States or its contractors.

(6) Prevent future encroachment or modifications, which might interfere with proper functioning of the project.

(7) Participate in the National Flood Insurance Program and other applicable Federal flood plain management programs.

(8) Provide guidance and leadership to prevent unwise future development in the flood plain.

b. Nonstructural Measures.

(1) Provide thirty-five percent of total project costs. A five percent cash contribution is not required.

(2) Provide all LERRDs, credited to sponsor's share. If credited LERRDs are less than thirty-five percent, sponsor will pay the difference in cash. Payments during construction are preferred, but an option exists for payment beginning upon construction completion. Deferred payments require ASA(CW) agreement. If LERRDs are more than thirty-five percent, the excess is reimbursed by the Federal Goverment.

(3) When LERRDs are more than thirty-five percent an agreement between the sponsor and the Federal Government on the most efficient and practical means for acquiring the excess LERRDs is required.

(4) Operate, maintain, repair, replace and rehabilitate completed project including, for a flood warning system, development and adoption of a detailed response plan. This plan must be acceptable to the Corps.

(5) Participate in the National Flood Insurance Program and other applicable Federal flood plain management programs.

(6) Nonstructural measures are always cost shared as nonstructural measures, even if they are mitigating for damages induced by structural measures of the same project.

(7) Other standard items included under structural measures will apply where appropriate.

SECTION 219 OF

WRDA 1999

Appendix C

CECW-PD 22 January 2001

MEMORANDUM FOR COMMANDERS, MAJOR SUBORDINATE COMMANDS AND DISTRICT COMMANDS

SUBJECT: Implementation Guidance for Section 219 of the Water Resources Development Act of 1999, Nonstructural Flood Control Projects

1. Purpose. The purpose of this memorandum is to provide guidance for the analysis of nonstructural flood control projects in accordance with Section 219 of the Water Resources Development Act of 1999 (WRDA 99). Section 73 of the Water Resources Development Act of 1974 requires consideration of nonstructural alternatives in flood damage reduction studies.

2. Applicability. All projects proposed after the date of enactment of WRDA 99 are required to use the procedures described in this guidance. This includes projects proposed for congressional authorization as well as Section 205 projects approved after the date of enactment of WRDA 99.

3. Section 219 (a) of WRDA 99 directs that the Corps calculate benefits for nonstructural flood damage reduction using methods similar to those used in calculating the benefits for structural projects, including similar treatment in calculating the benefits from losses avoided. It further states that in carrying out this directive, the Corps should avoid double counting of benefits. Nonstructural projects, such as floodproofing, raising homes and flood warning, already use the same method to calculate flood damage reduction benefits as structural projects and therefore no change is required in analytical procedures for these types of projects. However, Army Corps of Engineers Planning Guidance currently directs the use of only the externalized portion of flood damages prevented in calculating benefits for evacuation projects. For evacuation projects, the current guidance *explicitly* assumes that the internalized portion of flood damages is reflected in reduced market value of the properties used in the calculation of evacuation costs (i.e., the cost of buyout of the floodplain). This internalized portion includes uninsured losses, flood insurance premiums, any deductible and agent's fees. Typically, externalized flood damages are developed by calculating total flood damages using standard depreciated replacement cost techniques as in structural flood control projects. Then the internalized portion of flood damages are subtracted. The subtraction of the internalized portion of flood damages is intended to remove potential double counting from the benefit-cost calculation. The following new procedures will be used to implement section 219 (a):

SUBJECT: Implementation Guidance for Section 219 of the Water Resources Development Act of 1999, Nonstructural Flood Control Projects

a. Benefit Calculation. Flood damage reduction benefits for evacuation projects will be calculated as the total flood damages reduced. No correction will be made to remove the internalized portion of flood damages in the benefit calculation.

b. Real Estate Costs. In order to avoid double counting of the internalized portion of flood damages reduced, adjustments need to be made to the real estate costs used in the benefit-cost calculation. Economic analysis for evacuation alternatives will henceforth use comparable flood-free land costs in the valuation of floodplain land. Flood-free land cost is the cost of comparable flood-free land but without the flood-risk (defined as outside the FIA-designated 100-year floodplain). For the purposes of this guidance, land costs are defined as the land and associated structures.

(1) Cost information developed by Real Estate personnel during the feasibility study should be used for this cost calculation. As part of the Real Estate Plan, the cost (market value) to acquire the floodplain property is determined by a gross appraisal. Additionally, for residential properties under Public Law 91-646, the amount by which the market value of a replacement dwelling (non-floodplain property) exceeds the market value of the displacement dwelling (floodplain property) also is determined. This cost (the market value of the floodplain property, land and structures, plus any additional amount to equal the market value of a comparable replacement dwelling outside the floodplain) is the flood-free property cost. A comparable replacement residential property under Public Law 91-646 means a dwelling that is decent, safe, and sanitary and one that is similar with respect to features, size and location. However, for purposes of this calculation, if the floodplain dwellings are not up to decent, safe, and sanitary standards, the incremental cost to upgrade to a decent, safe, and sanitary home is considered a betterment and must be subtracted from the flood-free cost. Also, where last resort housing is anticipated, the market value of a comparable home outside the floodplain should be used, without regard to whether the home is available for acquisition.

(2) Comparable flood-free estimates for non-residential properties are not developed for compliance with Public Law 91-646. However, this information will now be required and can be developed by comparing property characteristics with information available on a multiple listing service or similar service. Coordination and involvement of real estate personnel is essential in determining appropriate non-floodplain land values.

c. The determination of non-floodplain land values will be described and documented in all decision documents where evacuation plans are considered. Note that this adjustment in costs is intended for use in the economic evaluation only and should not otherwise affect the financial costs associated with evacuation of the floodplain.

SUBJECT: Implementation Guidance for Section 219 of the Water Resources Development Act of 1999, Nonstructural Flood Control Projects

4. Section 219 (b) provides for the reevaluation of a previously authorized flood control project to consider nonstructural alternatives in light of the economic evaluation changes made by Section 219(a) of the Act if requested by a non-Federal interest. The following procedures will be used to implement section 219 (b).

a. In general, the reevaluation of authorized projects to consider nonstructural procedures shall be performed in a matter consistent with review of a completed project or restudy of a deferred project as described in the annual program EC. In all cases an initial appraisal and a reevaluation study at 50-50 cost sharing will be required. If the project has already been constructed, reevaluation will follow the procedures for "Review of a Completed Project" (Section 216) as described in the annual program EC. If the project is authorized but not yet constructed, an initial appraisal to determine whether the nonstructural alternative is justified is required. If the nonstructural alternative is justified, a cost-shared general reevaluation study would follow. Request for funding for such studies should follow normal budgetary procedures for a General Investigations new start.

b. Non-Federal interests must submit a written request for a reevaluation study to consider nonstructural alternatives through the District and Major Subordinate command (MSC). Districts will forward an assessment of the costs for the reevaluation along with the written request through MSC to HQUSACE (attn: CECW-B). Federal funds associated with the reevaluation will be subject to availability.

5. Section 219 (c) modifies Section 103(b) of the Water Resources Development Act of 1986 to clarify cost sharing for nonstructural measures. The section requires that at any time during construction of a nonstructural project, if the Corps determines that the costs of land, easements, rights-of-way, dredged material disposal areas, and relocations (LERRDs) for the project, in combination with other project costs contributed by the non-Federal sponsor, will exceed 35 percent, any additional costs for the project (not to exceed 65 percent of the total costs of the project) shall be a Federal responsibility and shall be contributed during construction as part of the Federal share. The purpose of this provision is to make clear that the Government should not wait until the final accounting is completed to reimburse the non-Federal sponsor for costs it has contributed above its 35 percent share of total project costs.

a. Current Corps policy is that the Government, through reimbursements, direct financing of construction, and/or the assumption of LERRD financing responsibilities, becomes responsible for all additional project costs as soon as the Government determines that the value of the non-Federal sponsor's contributions has reached 35 percent of total project costs. This determination and the follow-on financial actions could take place during construction. Therefore, current Corps policy is consistent with section 219(c)'s requirement that costs above the non-Federal sponsor's 35 percent share

shall be contributed by the Government during construction, rather than as a reimbursement following completion of the final accounting.

b. The existing model PCA for Section 205 nonstructural projects may be used as the basis for developing the PCA for a specifically authorized nonstructural project. District offices should contact HQUSACE (attn: CECW-PC) with any questions concerning nonstructural flood control project PCAs.

FOR THE COMMANDER:

/s/

JAMES F. JOHNSON
Chief, Planning and Policy Division
Directorate of Civil Works